

THE CAMAENID SPECIES OF THE KIMBERLEY ISLANDS, WESTERN AUSTRALIA (STYLOMMATOPHORA: HELICOIDEA)

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ABSTRACT

The present paper provides a complete overview of the camaenid land snail fauna of the 22 largest islands along the Kimberley coast, northwesternmost Western Australia, which were surveyed between 2007 and 2010. These islands were found to harbour a total of 104 species (83 new) in 15 genera (5 new), including taxa described recently. Species were essentially delimited by means of comparative analyses of shells (size, shape, sculpture, colouration), genital anatomy (in particular penial anatomy), and genetic differentiation in a mitochondrial marker (partial 16S rRNA sequences). Additionally, the radular and jaw morphology of selected species was studied but found to provide little useful information for taxonomic purposes. Species of the following genera are treated: *Amplirhagada* Iredale, 1933 (22 species), *Carinotrachia* Solem, 1985 (2 subspecies), *Kimberleymelon* Köhler, 2010 (1 species), *Kimberleydiscus* Köhler, 2010 (1 species), *Australocosmica* Köhler, 2011 (6 species), *Kimboraga* Iredale, 1939 (4 species), *Xanthomelon* Martens, 1860 (1 species), *Globorhagada* Iredale, 1933 (8 species; the name *Globorhagada* being removed from synonymy of *Xanthomelon*), *Rhagada* Albers, 1860 (8 species), *Retroterra* Solem, 1985 (3 species), *Baudinella* Thiele, 1931 (5 species), *Setobaudinia* Iredale, 1933 (14 species), *Torresitrachia* Iredale, 1939 (17 species or subspecies). In addition, two new genera, ***Molema***, n. gen. (one species) and ***Kimberleytrachia***, n. gen. (12 species), are described. The taxa *Torresitrachia umbonis* Solem, 1979, *T. deflecta* Solem, 1979, and *T. crawfordi* Solem, 1979, are transferred to the new genus ***Kimberleytrachia***. Species previously assigned to *Damochlora* are transferred to *Setobaudinia*; the former genus name likely being a junior synonym of the latter. The following species are delimited differently compared to the latest available revisions: “*Xanthomelon*” (now: *Globorhagada*) *prudhoensis* (E. A. Smith, 1894); “*Damochlora*” (now: *Setobaudinia*) *rectilabrum* (E. A. Smith, 1894); “*Torresitrachia*” (now: *Kimberleytrachia*) *umbonis* (Solem, 1979); *Torresitrachia amaxensis* Solem, 1979; *T. bathurstensis* (E. A. Smith, 1894). Most species were found to be island endemics. The work increases the number of known camaenids in northwestern Australia considerably and highlights the region as significant hotspot of land snail diversity.

Key words: Camaenidae, Pulmonata, taxonomy, land snail diversity, endemism, island fauna.

INTRODUCTION

The ancient landscapes of the Kimberley region of Western Australia are unique not only for their rugged beauty and inaccessibility, but also for the incredible biodiversity they support. Land snails are a component of this biodiversity that has received relatively little attention compared to vertebrate groups. Nonetheless, earlier works uncovered a large diversity of land snail species particularly in the rainforests (Solem, 1979, 1981a, b, 1984, 1985a, b, 1988, 1989, 1991, 1997).

These pioneering works showed that the land snail fauna of northwestern Australia is dominated by members of one family, the Camaenidae. Camaenid snails have developed adaptations that enable them to occupy a range of habitats from tropical rainforests to near deserts. In the Kimberley, centres of high diversity appear to be the wetter coastal areas in the northwest, where rainforest patches, including vine thickets, are most common. Prior to the Kimberley Island Survey, 185 camaenid land snail species in 23 genera were known from the Kimberley and immediately adjacent areas of

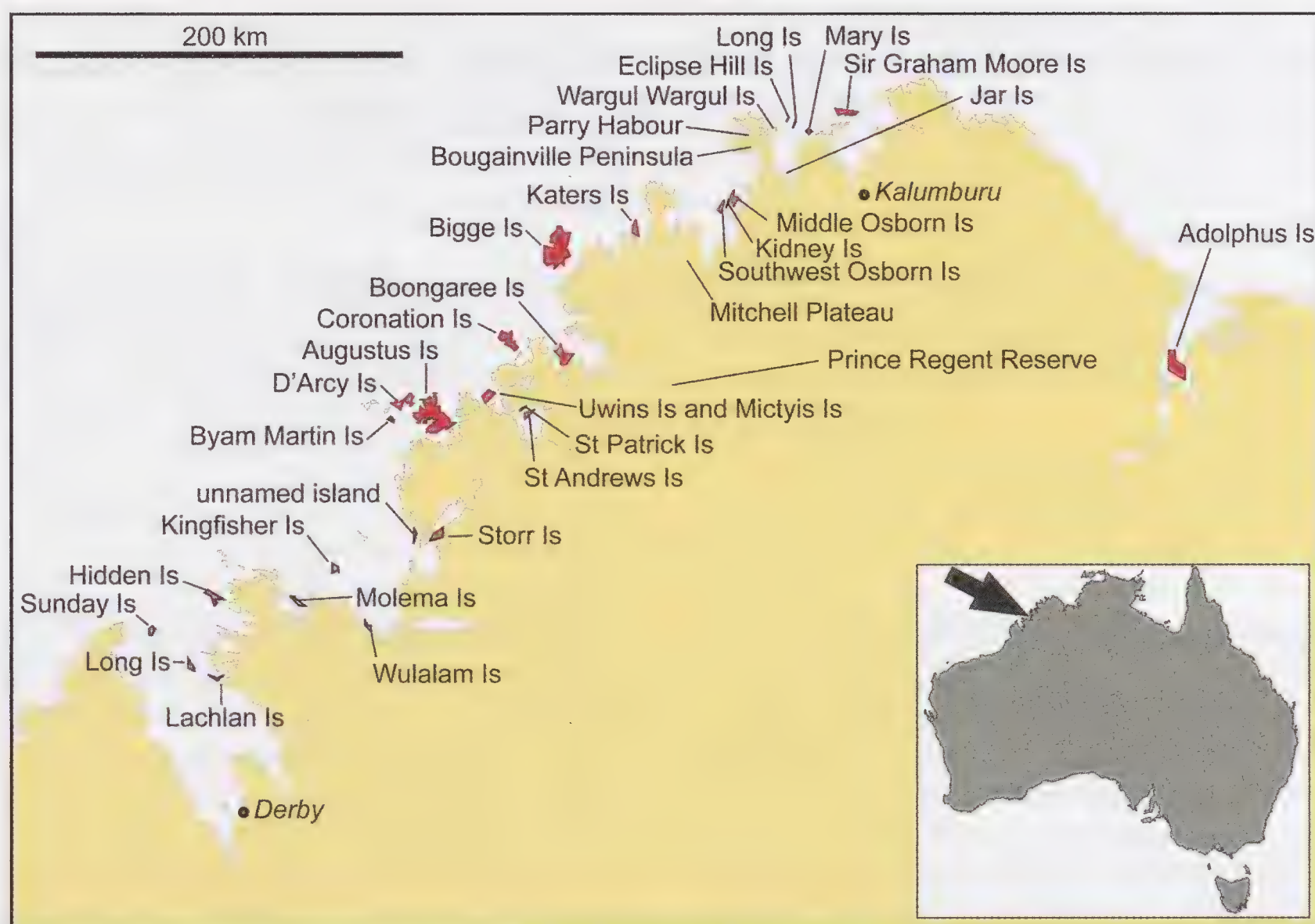


FIG. 1. Map of the Western Australian Kimberley with names of surveyed islands and other relevant localities.

the Northern Territory. This is the largest known regional diversity of camaenids in Australia. All species and almost all genera are endemic to the Kimberley region. In general, camaenid species have restricted geographic ranges, with an average range size on the mainland of no more than 20 square kilometres (Solem, 1991). Some species are even found on only a single rock outcrop, with a range diameter of mere metres (Willan et al., 2009).

Extensive archipelagos and island groups created by the drowning of an ancient coastline are found along the present day coast. There are hundreds of islands along the Kimberley coast, with 155 of them bigger than 100 hectares and 22 of more than 1,000 hectares. While these archipelagos represent much of the adjacent mainland's geology and vegetation types, the land snail fauna of most islands has widely remained unknown with usually only opportunistic reports being available.

From 2007 to 2010, a biodiversity survey was conducted on the largest islands by the Department of Environment and Conservation of Western Australia in collaboration with the Kimberley Land Council, the Western Australian Museum and the Australian Museum. Focussing on mammals, reptiles, frogs, birds, plants and land snails, this survey aimed to

expand knowledge of biodiversity across the variety of islands.

While some taxonomic outcomes of the survey have already been published (Köhler, 2010a–c, 2011), the present paper provides a complete overview of the camaenid fauna of these islands along the Kimberley coast with emphasis on patterns of species diversity across the archipelagos and in comparison with findings for the mainland.

MATERIAL AND METHODS

Material

This account is based on ethanol preserved specimens and supplementary dry shell material collected during the Kimberley Island Survey (KIS) of the Department of Environment and Conservation, Western Australia (DEC) in 2007–2010. Voucher material and types are deposited in the Western Australian Museum, Perth (WAM), and the Australian Museum, Sydney (AM). Some additional samples from the Field Museum of Natural History, Chicago, Illinois (FMNH), were also studied. The location of the surveyed islands is shown in the map in Figure 1.

Field Work

Field work on the islands was conducted in survey teams with one person usually being responsible for snail collecting. Snails were collected in walking distance (i.e., < 3 km) of one or two collecting sites per island, which were carefully chosen by use of satellite images to ensure that different vegetation types and geological structures are covered. Emphasis was put on rainforest vegetation, including vine thickets, and gullies and gorges, being preferred by the snails for higher humidity. Each collecting site was visited twice a year by helicopter. In the dry season (May to August) sites were visited for five consecutive days and suitable habitats and structures (crevices in rocks, soil, leaf litter, rock piles etc.) were carefully searched for aestivating snails. All sites were visited again in the following wet season (February) for a single day. During this period of time snails were usually collected when being active.

Anatomical Studies

Samples from each collection site were initially sorted into morphotypes based on external shell morphology. Preliminary identifications were based on comparisons with type material or topotypical material of known species. Comparative analyses of morphometric parameters of adult shells (recognised by complete lip) and features of the genital anatomy were employed to test whether operating units were correctly delimited and to confirm the preliminary determinations. Adult shell parameters were measured with a caliper precise to 0.1 mm. Parameters used were shell height (H = maximum dimension parallel to axis of coiling, including lip), shell diameter (D = maximum dimension perpendicular to H , including lip), width of umbilicus (U = diameter at half of total depth), height of last whorl (LW = maximum dimension from lower margin of aperture to upper suture delimiting the first whorl). The number of whorls (N), including protoconch, was counted precise to 0.1 as shown in Figure 2. The parameter “angle of mouth” describes the angle formed between aperture and the horizontal in degrees when the shell is in an upright position. The morphometric shell parameters H , D , LW , U , N , and H/D were subjected to morphometric analyses when considered necessary for the delimitation of species. Anatomy of genital organs was studied using a Leica M8 stereo microscope with drawing mirror. If not stated otherwise, the final

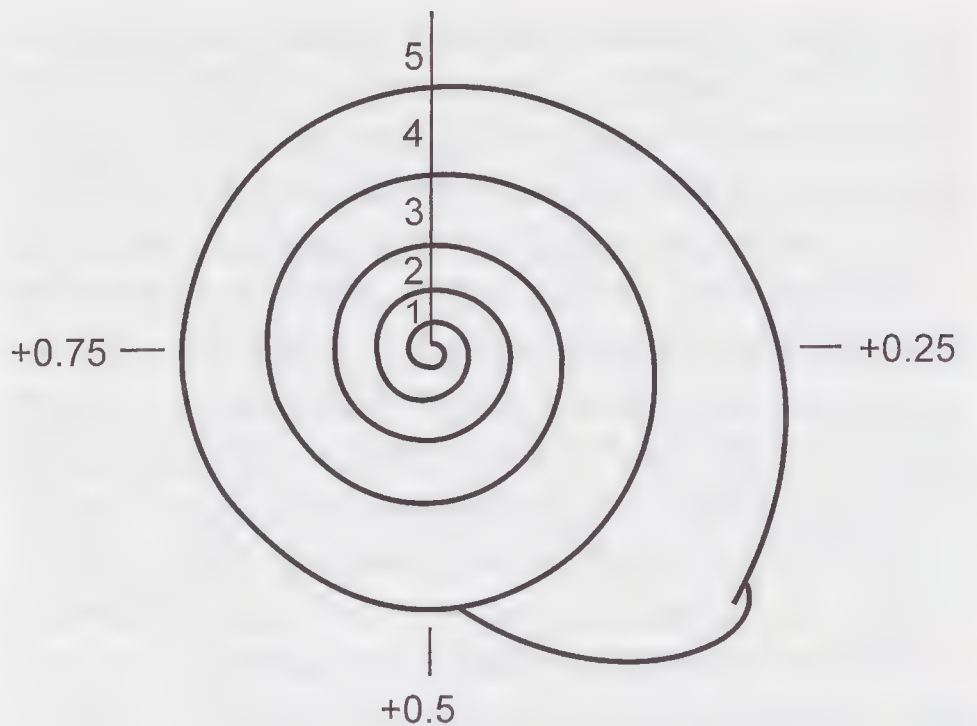


FIG. 2. Method of whorl count.

inking of drawings was done by Martin Püschel (Sydney), some drawings of *Setobaudinia* were inked by Michael Shea (Sydney). Radulae and jaws were extracted manually, cleaned by soaking in 10% KOH solution for about six hours followed by rinsing in water and ethanol. They were mounted on carbon specimen tabs for electron scanning microscopy. Radular tooth formula gives the numbers of teeth as follows: C (central row of teeth) + number of lateral rows of teeth + number of transitional rows of teeth + number of marginal rows of teeth. Anatomy was studied from two (in small series) to five specimens per sample in order to confirm that observed features are consistently found among conspecific specimens.

Clarification of Terms

For the description of shell features, in particular the microsculpture, terminology of Stanisic et al. (2010) is used. In verbal descriptions of the genital anatomy, with regard to the location of structures relative to each other, the terms “proximal” (= near) and “distal” (= far from) refer to the relative distance to the atrium, which sits antero-ventrally, whilst the genital tract extends towards the posteriorly distal portion of the body. Hence, proximal and anterior as used herein are synonymous with each other as are distal and posterior.

In descriptions of features of the reproductive anatomy, Solem (1979, 1981a, b, 1984, 1985a, 1997) partly employed his own terminology, which has often been not consistent with the terms employed elsewhere. While Solem’s terminology was widely followed by Köhler (2010a, b, 2011), here the attempt is made to be consistent with the general use of terms in

land snail systematics. Solem referred to “prostate” (for prostate gland) and “uterus”, terms that are widely used in land snail systematics. However, because both structures are fused in camaenids, instead the term “spermoviduct” is preferred here, which refers to the portion of the genital tract where prostate gland and uterus are fused with each other. Clarification of the term “spermatheca” as employed by Solem for Australian camaenids and subsequently followed by Clark (2009) and Köhler (2010, 2011) is required. In general, “spermatheca” refers to an organ in which allospermatozoa are stored and kept viable after copulation. Therefore, a spermatheca is identical with a seminal receptacle. However, in camaend snails the structure for which the term “spermatheca” was employed by Solem and others is a gametolytic gland but not a sperm-storing organ (Thompson & Bebbington, 1969; Brandriff & Beeman, 1973). Thus, the more widely used and correct term “bursa copulatrix” is applied instead (see also Barker, 1999: 27).

Frequently, the way how the epiphallus or the vas deferens (when a well-differentiated epiphallus is not present) opens into the lumen of the phallus is a characteristic feature. In some taxa, the vas deferens or epiphallus opens through a tubular penial verge, which is termed “verge”. In other taxa, this vergic papilla is reduced in size (i.e., forming a “vergic ring”) (Barker, 1999: 27). Instead of “epiphallic caecum”, a term employed by Solem (also referred to as “epiphallus appendix” [sic!] by Jordaens et al., 2009), the most widely used term is actually “epiphallic flagellum” (e.g., Duncan, 1975; Tompa, 1984; Clark, 2009; Jordaens et al., 2009), which is hence preferred herein. The “vagina” is the most proximal part of the female oviduct extending from the atrium to the branching between bursa copulatrix and oviduct. The “free oviduct” is the part of the oviduct extending from the distal end of the vagina to the proximal end of the spermoviduct (uterus and prostate gland). The “anterior part of the oviduct” comprises vagina and free oviduct.

The development and relative size of some genital structures depends on the maturity of the animal and on its actual reproductive state. For dissection of genitalia, fully mature specimens (with adult shell features and fully developed albumen gland) were always chosen. However, amongst these specimens seasonal variation can be found with the genitalia being inactive and reduced in size in animals collected during the early to mid dry season (~ May to August) (Solem & Christensen, 1984).

Because unavoidably the dissected specimens were collected at different times of the year, for each genital drawing the month of collection is given.

The following abbreviations are used:

ag	albumen gland
at	atrium
bc	bursa copulatrix
cl	corrugated lamellae
csw	connection of penial sheath and penial wall
ct	connective tissue
ef	epiphallic flagellum
el	epiphallic lobe
ep	epiphallus
epp	(longitudinal) epiphallic pilasters
fo	free oviduct
ft	foot
gr	sperm groove (of penial verge)
gu	gutter (on inner penial wall)
hd	hermaphroditic duct
hw	head wart
iw	inner penial wall
ll	lateral lamaellae
lp	longitudinal pilaster (of inner penial wall)
mp	main stimulatory pilaster (of inner penial wall)
op	oblique pilasters (of inner penial wall)
ov	opening to vas deferens (within epiphallus)
p	penis
pa	penis detached from atrium
pd	pad-like thickening of inner penial wall
pu	pustulation (of inner penial wall)
pv	penial verge
rm	penial retractor muscle
s	shell
sh	penial sheath
so	spermoviduct
tn	tentacle
vn	vagina
vd	vas deferens
vp	vergic papilla
vr	vergic ring

Molecular Work

DNA was extracted from small pieces of foot muscle by use of a QIAGEN DNA extraction kit for animal tissue following the standard procedure of the manual. A fragment of the mitochondrial 16S rRNA gene (16S) was amplified by PCR using the primers 16Scs1 (Chiba, 1999a) and 16Sbd1 (Sutcharit et al., 2007). Reactions were performed under standard conditions with an annealing step of 90 s at 55°C. Sequences were aligned by use of the on-line version of MAFFT (Kato et al., 2002) available at <http://mafft.cbrc.jp/alignment/server/> using the “E-INS-I” strat-

egy and standard parameters. The aligned sequence data set comprised 304 sequences and was trimmed to a total length of 827 bp. The sequence data was used to calculate uncorrected pair-wise genetic p-distances with the software MEGA 4.0 (Tamura et al., 2007) under the option “pair-wise deletion of gaps” in order to estimate the genetic differentiation of taxa. A phylogenetic analysis of mitochondrial sequences was not performed herein because a more complete phylogeny of the Western Australian Camaenidae under preparation is due to be published elsewhere. However, all taxa delimited herein by their morphology form monophyletic clades in mtDNA phylogenies based on analyses of 16S Köhler (2009, 2010c, unpublished data).

SYSTEMATIC PART

Within genera, species are listed in a north-south order of their occurrence along the Kimberley coast.

Gastropoda
Heterobranchia
Stylommatophora
Helicoidea Rafinesque, 1815
Camaenidae Pilsbry, 1895

Taxonomic Remarks

Delimitation of the Camaenidae is controversial. It has essentially been defined by lack of a dart apparatus (Pilsbry, 1939), a character state demonstrated likely to be plesiomorphic (Scott, 1996; Wade et al., 2007). Here, I follow Shileyko (2003) and Bouchet & Rocroi (2005) with regard to delimitation of the family (i.e., excluding New World taxa), but remark that the Camaenidae as so delimited remain non-monophyletic with respect to the Bradybaenidae, which possess a dart apparatus. Typical characters as given here for the family apply to Australian Camaenidae only, which are nested within a large camaenid-bradybaenid radiation (Wade et al., 2007; Hugall & Stanisic, 2010). All subfamilial treatments previously suggested are not well supported by available phylogenetic data and are therefore in need of critical revision (Hugall & Stanisic, 2011).

Diagnosis

Australian helicoid taxa with variable shell, widely to narrowly winding umbilicus that may

be partly to completely concealed by columellar reflection, undivided sole, elongate kidney, lacking dart apparatus, penial glands, diverticulum of bursa copulatrix, perivaginal glands and atrial appendix; uterus and prostate fused forming spermoviduct; inner wall of vagina, anterior oviduct and spermatophore with longitudinal pilasters; albumen gland elongate; talon simple, embedded within proximal part of albumen gland, sitting laterally. Hermaphroditic duct tightly undulating. Radula rectangular in shape; central teeth with triangular mesocones, tiny or vestigial ectocones; lateral teeth with triangular mesocones, tiny to vestigial ectocones and endocones; marginal teeth multicuspid, mesocones and endocones similar in length, ectocones smaller than endocones, occasionally subdivided.

Amplirhagada Iredale, 1933

Amplirhagada Iredale, 1933: 52; Solem, 1981a: 147–320; 1985a: 935–938; 1985b: 143–136; 1988: 28–32; 1991: 187–202; Solem & McKenzie, 1991: 247–263; McKenzie et al., 1995: 251; Johnson et al., 2010: 141–153; Köhler, 2010a: 217–284. Type species *Helix (Hadra) sykesi* E. A. Smith, 1894, by original designation.

Tenuigada Iredale, 1939: 68. Type species *Tenuigada percita* Iredale, 1939, by original designation.

Diagnosis

Shell: Medium sized (D = 15–30 mm; Table 1), thin (translucent) to moderately thick, broadly conical to dome- or beehive-shaped, moderately to strongly elevated; umbilicus narrowly winding, completely concealed to (rarely) entirely open; protoconch with very weak to strong, radially elongated pustulation; teleoconch sculptured by faint radial growth lines to well-developed radial ribs, ribs becoming oblique on base of shell; whorls rapidly increasing, separated by shallow to moderately deep suture; periphery well rounded to angulated. Shell colour variable, background often yellowish brown to horn, frequently banded, with brown subsutural and peripheral bands, or more rarely uniform.

Radula: 3.5–5.5 mm long, with 120–170 rows of teeth, C + 12–20 + 3–4 + 15–22.

Genital anatomy: Penis with well-developed sheath, extending entire length, usually thick proximally, thin distally; inner penial wall sculpture varying from smooth to heavily sculptured; epiphallus absent or wanting; penial retractor

TABLE 1. Shell parameters of *Amplirhagada*. Given are maximum – minimum (mean $\pm$ standard deviation) of shells for N measured specimens. Abbreviations used: HT = holotype, PT = paratype. Note that the method of whorl count differs from that applied by Köhler (2010b), who excluded the protoconch.

Species	N	Height (H)	Diameter (D)	Height of Last Whorl (LW)	Umbilicus (U)	No. of Whorls	H/D Ratio
<i>A. euroa</i>	13	12.3–13.9 (13.0 $\pm$ 0.5)	18.5–20.3 (19.6 $\pm$ 0.4)	9.6–11.0 (10.4 $\pm$ 0.4)	chink	4.6–4.9 (4.8 $\pm$ 0.1)	0.62–0.70 (0.66 $\pm$ 0.02)
<i>A. burrowsena</i>	28	14.0–19.8 (16.1 $\pm$ 1.3)	18.9–23.6 (20.7 $\pm$ 1.2)	8.5–11.0 (9.6 $\pm$ 0.5)	0–2.5	4.7–5.8 (5.4 $\pm$ 0.3)	0.68–0.86 (0.78 $\pm$ 0.05)
<i>A. solemiana</i>	20	9.9–12.2 (11.2 $\pm$ 0.6)	16.2–18.4 (17.6 $\pm$ 0.6)	8.3–10.0 (9.3 $\pm$ 0.4)	0–1.0	4.0–5.1 (4.6 $\pm$ 0.3)	0.59–0.69 (0.63 $\pm$ 0.03)
<i>A. indistincta</i>	35	11.4–16.6 (13.8 $\pm$ 1.2)	18.5–21.2 (19.7 $\pm$ 0.7)	7.9–12.7 (10.1 $\pm$ 1.5)	close-chink	4.2–5.0 (4.6 $\pm$ 0.2)	0.58–0.81 (0.70 $\pm$ 0.05)
<i>A. katerana</i>	45	12.8–20.9 (15.9 $\pm$ 1.8)	19.3–25.0 (22.1 $\pm$ 1.5)	10.0–14.2 (11.9 $\pm$ 1.0)	chink to narrow	4.3–5.6 (5.0 $\pm$ 0.3)	0.60–0.84 (0.72 $\pm$ 0.06)
<i>A. decora</i>	23	14.8–20.6 (17.8 $\pm$ 1.4)	18.2–22.0 (19.9 $\pm$ 0.9)	10.4–14.4 (12.6 $\pm$ 0.8)	close	3.5–4.7 (4.3 $\pm$ 0.3)	0.79–1.04 (0.89 $\pm$ 0.06)
<i>A. kessneri</i>	16	9.7–14.9 (12.4 $\pm$ 1.4)	15.0–21.6 (19.0 $\pm$ 1.8)	6.7–8.5 (7.6 $\pm$ 0.5)	0–2.5	4.0–5.0 (4.6 $\pm$ 0.3)	0.61–0.71 (0.65 $\pm$ 0.03)
<i>A. boongareensis</i>	28	15.1–22.8 (20.0 $\pm$ 1.8)	18.9–21.9 (20.6 $\pm$ 0.8)	8.1–12.9 (9.4 $\pm$ 1.2)	close-chink	4.5–6.8 (6.0 $\pm$ 0.6)	0.80–1.12 (0.97 $\pm$ 0.07)
<i>A. gibsoni</i>	16	12.0–14.9 (13.3 $\pm$ 0.7)	17.1–19.2 (18.1 $\pm$ 0.7)	6.4–10.6 (8.1 $\pm$ 1.4)	chink	4.4–5.6 (5.2 $\pm$ 0.3)	0.70–0.82 (0.74 $\pm$ 0.03)
<i>A. regia</i>	20	14.5–18.2 (16.6 $\pm$ 1.0)	21.8–26.0 (23.4 $\pm$ 1.1)	11.4–14.6 (13.0 $\pm$ 0.7)	close-chink	5.0–5.5 (5.3 $\pm$ 0.1)	0.64–0.79 (0.71 $\pm$ 0.05)
<i>A. yorkensis</i>	15	8.4–10.4 (9.4 $\pm$ 0.6)	15.5–18.8 (17.3 $\pm$ 0.9)	7.2–8.6 (8.0 $\pm$ 0.4)	2.0–2.5	4.1–4.5 (4.3 $\pm$ 0.1)	0.49–0.60 (0.54 $\pm$ 0.03)
<i>A. uwinsensis</i>	23	14.3–17.1 (15.6 $\pm$ 0.7)	20.0–23.2 (21.7 $\pm$ 0.8)	11.3–13.2 (12.2 $\pm$ 0.4)	close	5.8–6.4 (6.1 $\pm$ 0.2)	0.66–0.76 (0.72 $\pm$ 0.02)
<i>A. sphaeroidea</i>	8	13.5–15.8 (14.9 $\pm$ 0.7)	20.9–23.0 (22.0 $\pm$ 0.7)	11.1–12.9 (11.9 $\pm$ 0.5)	close-chink	5.2–5.5 (5.3 $\pm$ 0.1)	0.62–0.72 (0.68 $\pm$ 0.03)
<i>A. cf. pusilla</i>	5	9.5–10.1 (9.7 $\pm$ 0.2)	16.7–18.0 (17.6 $\pm$ 0.5)	6.4–7.3 (7.0 $\pm$ 0.3)	1.8–2.3 (2.1 $\pm$ 0.2)	4.5–4.9 (4.7 $\pm$ 0.2)	0.53–0.59 (0.55 $\pm$ 0.02)
<i>A. globosa</i> n. sp.	HT	13.8	20.4	7.9	chink	5.8	0.68
	16	13.8–15.4 (14.5 $\pm$ 0.5)	18.4–20.6 (19.4 $\pm$ 0.5)	7.1–8.0 (7.5 $\pm$ 0.3)	chink	5.3–5.9 (5.6 $\pm$ 0.2)	0.68–0.84 (0.74 $\pm$ 0.03)
<i>A. basilica</i>	13	14.4–17.2 (15.7 $\pm$ 0.7)	22.1–27.0 (23.6 $\pm$ 1.2)	11.9–13.1 (12.6 $\pm$ 0.4)	chink	5.1–5.4 (5.2 $\pm$ 0.1)	0.56–0.73 (0.66 $\pm$ 0.04)
<i>A. camdenensis</i>	11	14.8–17.3 (16.2 $\pm$ 0.8)	18.7–19.8 (19.2 $\pm$ 0.4)	11.1–12.3 (11.6 $\pm$ 0.3)	0–2.5	4.8–5.3 (5.2 $\pm$ 0.1)	0.78–0.89 (0.85 $\pm$ 0.03)
<i>A. sinenomine</i> n. sp.	17	13.5–18.2 (15.8 $\pm$ 1.3)	18.2–22.2 (19.7 $\pm$ 1.1)	8.5–10.8 (9.5 $\pm$ 0.6)	close	5.3–6.0 (5.6 $\pm$ 0.2)	0.74–0.88 (0.80 $\pm$ 0.03)
<i>A. storriana</i> n. sp.	HT	18.3	21.0	9.5	chink	6.0	0.87
	24	16.1–20.0 (18.5 $\pm$ 0.8)	19.8–22.5 (21.2 $\pm$ 0.7)	8.2–13.5 (8.9 $\pm$ 1.1)	chink	5.1–6.0 (5.7 $\pm$ 0.2)	0.76–0.96 (0.87 $\pm$ 0.05)
<i>A. alkuonides</i> n. sp.	HT	13.7	21.7	9.0	chink	5.5	0.63
	25	11.7–16.5 (13.7 $\pm$ 1.1)	17.6–22.3 (20.6 $\pm$ 1.1)	6.6–9.3 (7.9 $\pm$ 0.5)	chink	5.0–5.9 (5.6 $\pm$ 0.3)	0.60–0.74 (0.66 $\pm$ 0.03)
<i>A. cf. astuta</i>	1	12.8	22.7	8.0	2.5	4.9	0.56

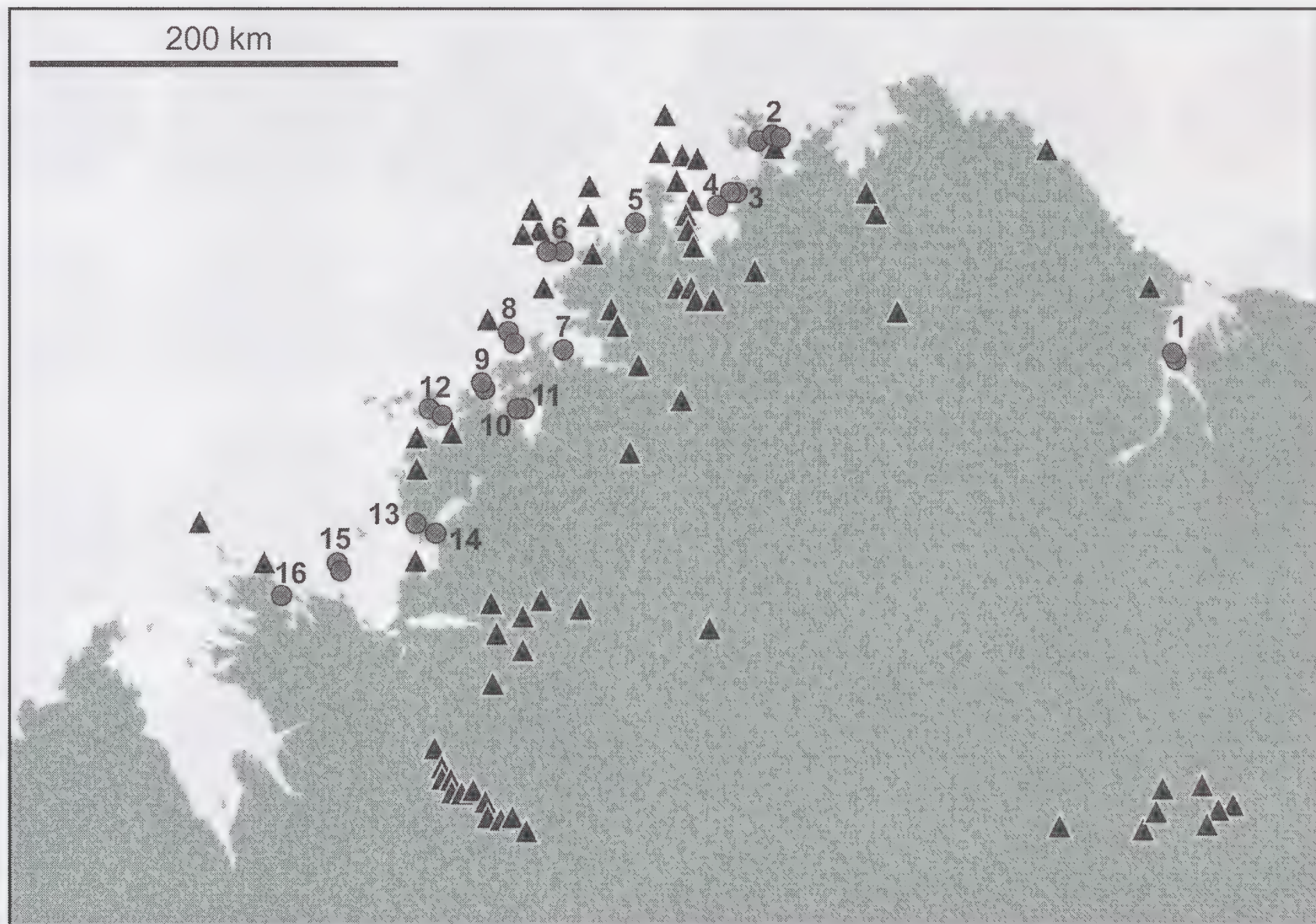


FIG. 3. Distribution map of *Amplirhagada*. Circles = Records of species treated herein: 1: *A. euroa* (Adolphus Island). 2: *A. burrowsena* (Bougainville Peninsula, Wargul Wargul and Eclipse Hill Islands, Vansittart Bay). 3: *A. solemiana* (Middle Osborn Island). 4: *A. indistincta* (Southwest Osborn and Kidney Islands). 5: *A. katerana* (Katers Island). 6: *A. decora* and *A. kessneri* (Bigge Island). 7: *A. boongareensis*, *A. gibsoni*, *A. regia* and *A. sp.* (Boongaree Island). 8: *A. yorkensis* (Coronation Island). 9: *A. uwinsensis* (Uwins and Mictyis Islands). 10: *A. globosa* n. sp. (St Patrick Island). 11: *A. sphaeroidea* and *A. cf. pusilla* (St Andrews Island). 12: *A. camdenensis* and *A. basilica* (Augustus Island). 13: *A. sinenomine* n. sp. (unnamed island in Doubtful Bay). 14: *A. storriana* n. sp. (Storr Island). 15: *A. alkuonides* n. sp. (Kingfisher and Melomys Islands). 16: *A. astuta* (Molema Island); triangles = Records of other congeneric species from the on-line catalogue of the Australian Museum.

muscle attached to junction with vas deferens. Vas deferens entering penial sheath halfway up to almost apically, entering penial chamber through verge. Bursa copulatrix simple, short (reaching or slightly extending anterior end of spermoviduct).

Aestivation Strategy

Rock or free sealer.

Taxonomic Remarks

Solem (1981a) provided the latest taxonomic revision and demonstrated that species are characterised particularly by penial features. Johnson et al. (2010) studied mitochondrial lineage differentiation (16S) of *Amplirhagada* populations across different islands in the Kimberley, which are not covered herein, showing

that spatially isolated populations separated by distances larger than 10 km form clades, which are differentiated by genetic distances of 16–27%. Köhler (2010a) by comparing levels of anatomical and mitochondrial differentiation, demonstrated that comparable levels of genetic differentiation in COI are indicative of interspecific lineage differentiation. Accordingly, corrected pair-wise genetic distances (Tamura & Nei, 1993) ranged between 26 and 35% while infraspecific distances did not exceed 4%.

Diversity and Distribution (Fig. 3)

Amplirhagada is endemic to the Kimberley and arguably the most diverse camaenid genus in this region. Species are found along the coast within a distributional range from the Buccaneer Archipelago in the south to



Kalumburu in the north as well as in inland areas of the Napier, Oscar, Harding, and King Leopold ranges, the Drysdale River Reserve, Mt. Elizabeth Station and the region south of Wyndham (Solem, 1981a, 1988; Köhler, 2010a). Thirty species were described by 19th and 20th century authors, such as Smith (1894), Iredale (1938, 1939) and Solem (1981a, 1988), while an additional twenty-six species were recently described by Köhler (2010a) bringing the total species number to 56. This figure does not include four species described here nor some additional 15 species from rainforest patches across the Kimberley, which await formal description (F. Köhler, unpublished data).

Amplirhagada euroa Köhler, 2010
Figs. 4A, 5

Amplirhagada euroa Köhler, 2010a: 220–222, figs. 2–4.

Type Locality

Western Australia, eastern Kimberley, Cambridge Gulf, eastern section of Adolphus Island, 15°06'32"S, 128°09'08"E.

Material Examined

Holotype WAM S34601. Paratypes AM C463680 (6 preserved specimens, as holotype), WAM S37083 (12 preserved specimens) from type locality, WAM S37390 (3 shells) from 15°06'18"S, 128°09'04"E; WAM S37391 (shell) from 15°06'35"S, 128°09'57"E; AM C463680 (6 shells), WAM S37392 (11 shells) from 15°06'32"S, 128°09'08"E; WAM S37393

(3 shells) from northern Adolphus Island, 15°04'19"S, 128°08'18"E.

Diagnosis

Shell: Broadly conical with low to medium spire; umbilicus 50–90% concealed (Fig. 4A, Table 1); teleoconch sculptured by fine axial lirae; colour yellowish brown, with chestnut brown, thin to moderately broad, diffuse to well-defined subsutural and peripheral bands, clearly visible on last whorls only.

Genital anatomy: Penial verge short, less than 1/5 of length of penial chamber, slender with rounded tip. Penial wall pustules normal to elongated, arranged in rows over entire length of inner penial wall. Main stimulatory pilaster large, cone-shaped, comprising entire length of inner penial wall; sculptured by ridges with smooth, flattened pustules (Fig. 5).

Comparative Remarks

Geographically well separated from most other congeners; species occurring closest are *A. cambridgensis* Solem, 1988 (from western bank of Cambridge Sound), and *A. questroana* Solem, 1981 (from El Questro Station near Wyndham, ~ 100 km S of Adolphus Island). While shells are similar, *A. euroa* differs in penial wall pustules forming corrugated longitudinal pilasters; *A. questroana* differs by an open umbilicus and a shorter and corrugated main stimulatory pilaster.

Distribution (Fig. 3)

Eastern Kimberley, Cambridge Gulf, Adolphus Island.

←

FIG. 4. Shells of *Amplirhagada* species (continued in Fig. 39). A: *A. euroa* paratype WAM S37392 (Adolphus Island); B: *A. burrowsena* WAM S49320 (Wargul Wargul Island); C: *A. solemiana* paratype WAM S36572 (Middle Osborn Island); D: *A. indistincta* paratype WAM S36499 (Southwest Osborn Island); E: *A. katerana* WAM S36580 (Katers Island); F: *A. decora* holotype WAM S34609 (Bigge Island); G: *A. kessneri* holotype WAM S34610 (Bigge Island); H: *A. boongareensis* holotype WAM S34616 (Boongaree Island); I: *A. gibsoni* holotype WAM S34617 (Boongaree Island); J: *A. regia* holotype WAM S34615 (Boongaree Island); K: *Amplirhagada* sp. WAM S36953 (Boongaree Island); L: *A. yorkensis* paratype WAM S37401 (Coronation Island); M: *A. uwinsensis* paratype WAM S37441 (Uwins Island); N: *A. sphaeroidea* holotype WAM S34622 (St Andrews Island); O: *A. cf. pusilla* WAM S37405 (St Andrews Island); P: *A. globosa* n. sp. holotype WAM S58432 (St Patrick Island); Q: *A. basilica* holotype WAM S34623 (Augustus Island); R: *A. camdenensis* holotype WAM S34624 (Augustus Island); S: *A. sinenomine* n. sp. paratype WAM S37709 (unnamed island in Doubtful Bay; sub-adult). T: *A. sinenomine* n. sp. paratype WAM S37805 (unnamed island in Doubtful Bay; adult). Scale bar = 10 mm. Note that foot tissue protrudes from some shells.

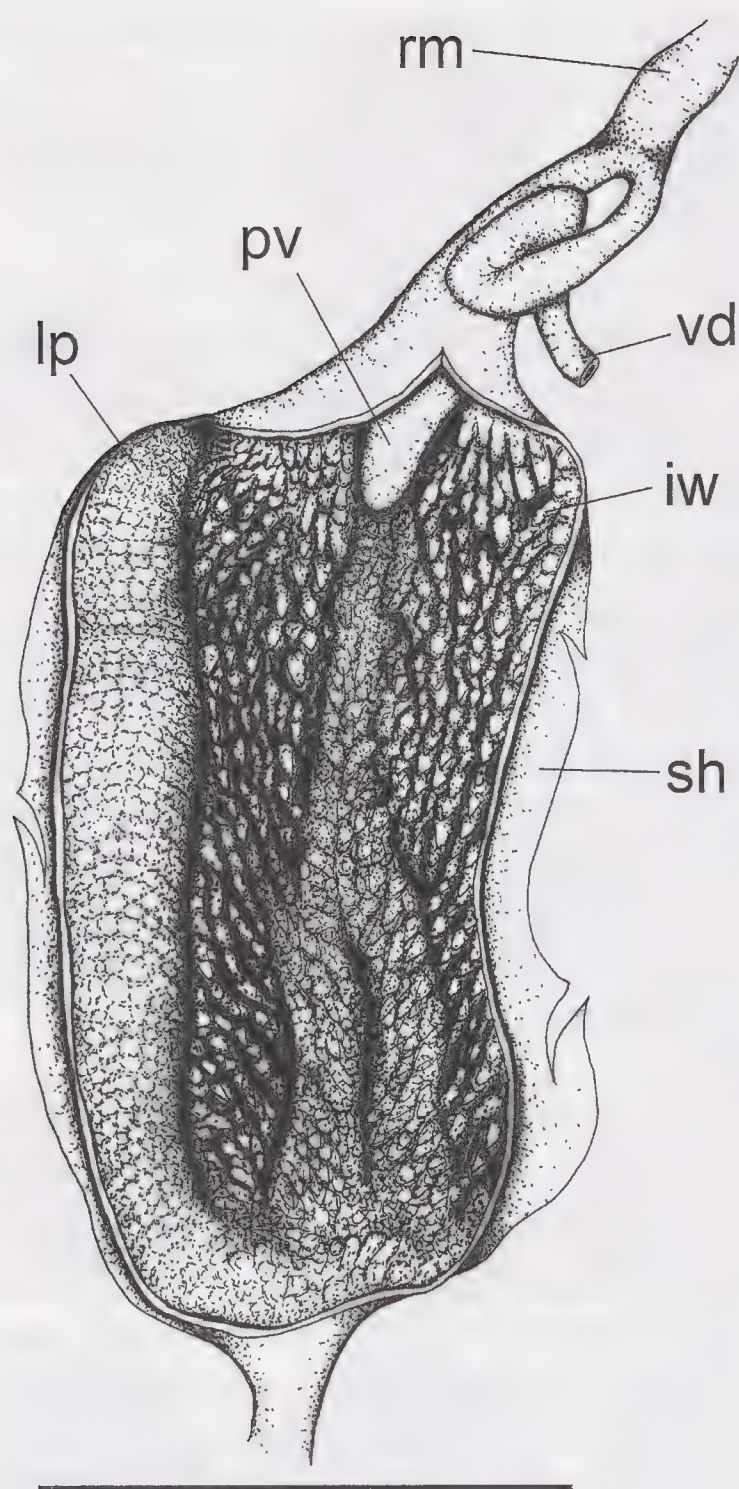


FIG. 5. Penial anatomy of *Amplirhagada euroa* (paratype AMS C463680, Adolphus Island; August). Scale bar = 5 mm.

Amplirhagada burrowsena Iredale, 1939
Figs. 4B, 6–8

Amplirhagada burrowsena Iredale, 1939: 68, pl. V, fig. 9 (Vansittart Bay, northwest Australia).

Amplirhagada imitata – Solem, 1981: 306–310 (partim).

Type Locality

Western Australia, northwestern Kimberley, Vansittart Bay.

Taxonomic Remarks

This species was named by Iredale (1939) based on three dried and worn shells from Vansittart Bay. It was subsequently treated as synonym of *A. imitata* (E. A. Smith, 1894) from Baudin and Condillac islands, Institute Islands by Solem (1981a) for having a similar shell.

Solem (1981a) also designated the lectotype of *A. burrowsena* (AM C106525). He assumed that *A. imitata* has a comparatively wide distribution spanning various islands in the Admiralty Gulf and the adjacent mainland coast. This assumption was not based on comparative study of preserved material that would have permitted dissection. Preserved material from the type locality of *A. imitata* (Baudin Island) is still not available. However, Köhler (2010a) showed that islands in close proximity of Baudin and Condillac islands, such as Fenelon and Descartes islands, harbour distinct species (*A. montesquieuana* Köhler, 2010, and *A. descartesana* Köhler, 2010, respectively). Hence, localities in much larger distance are considered unlikely to harbour conspecific populations, which would render the distribution of this species remarkably disjunct. Consequently, the name *A. burrowsena* is removed from synonymy of *A. imitata*. The anatomy is described for the first time based on material from localities around Vansittart Bay.

Material Examined

Lectotype AM C106525 (dry and worn shell); additional, non-type material WAM S49351 (3 preserved specimens), WAM S49327 (42 shells), AM C471708 (10 shells) from Bougainville Peninsula, Vansittart Bay, 13°55'58"S, 126°08'53"E; WAM S49355, WAM S49357–8, WAM S49364, AM C471710 (4 preserved specimens), WAM S49320–6, AM C471709 (30 shells) from Wargul Wargul Island, Vansittart Bay, N Kimberley, 13°56'S 126°10'E; WAM S49350 (8 preserved specimens), AM C471711 (10 shells), WAM S49328 (41 shells) from Eclipse Hill Island, Eclipse Archipelago, Vansittart Bay, 13°56'31"S, 126°17'01"E.

Description

Shell (Figs. 4B, 6; Table 1): Subglobose to broadly conical with moderately to highly elevated spire; thick to solid; periphery evenly rounded to slightly angulated; upper and basal sector of whorls well rounded. Umbilicus forming a chink (80–95% concealed), or completely concealed. Background colour whitish horn to yellowish brown, with well-defined to diffuse, moderately broad, subsutural and peripheral bands, usually visible on entire shell; ventral, outer and inner lip colour pale horn to white. Protoconch 2.3–2.7 mm in diameter, comprising one whorl, with comparatively strong axial ribs. Teleoconch with comparatively strong, regular

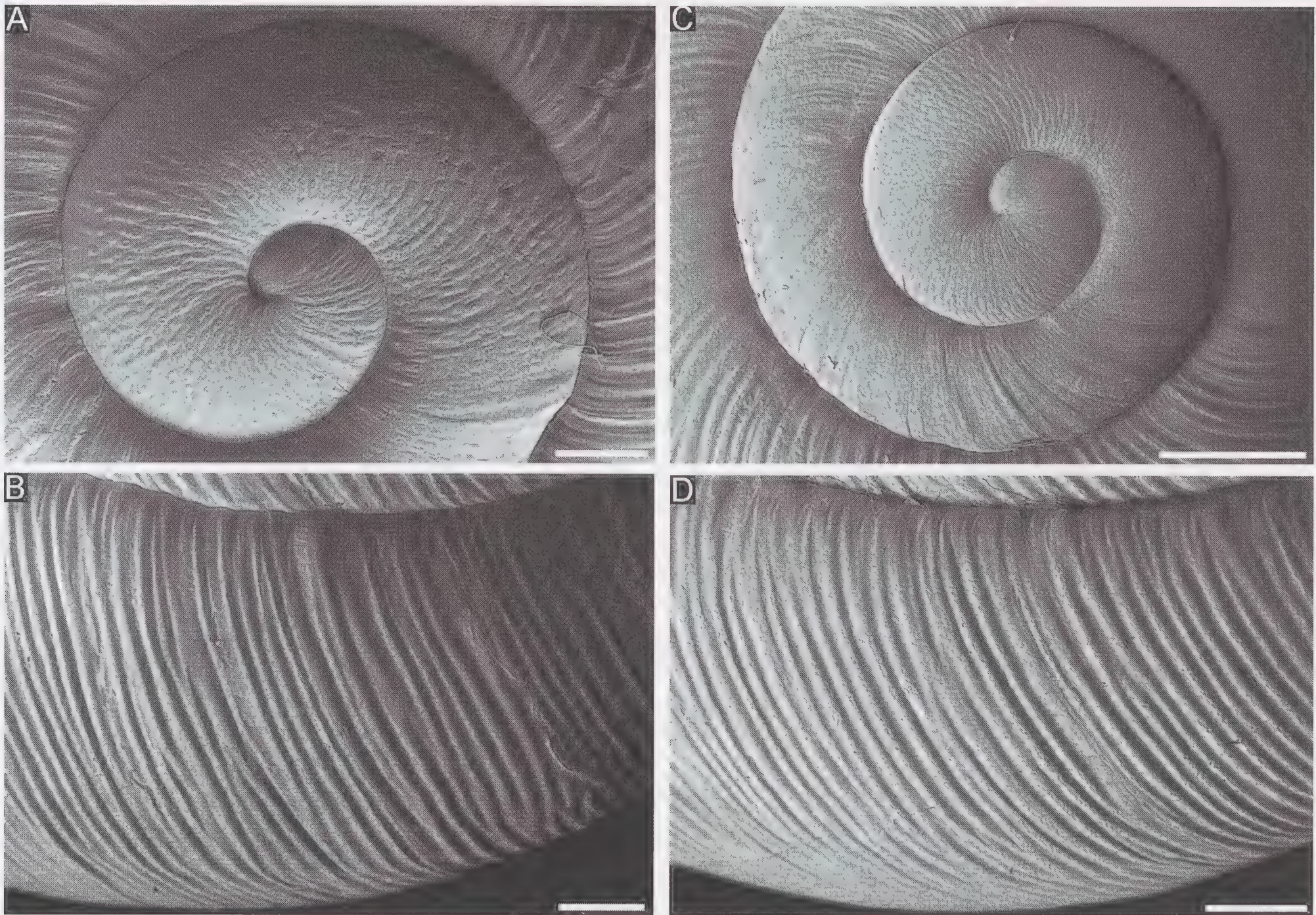


FIG. 6. SEM micrographs of the shell of *Amplirhagada burrowsena*. A–B: AM C471708, Bougainville Peninsula; A: Apical view showing protoconch, scale bar = 0.5 mm; B: Sculpture on last whorl, scale bar = 1 mm; C–D: AM C471709, Wargul Wargul Island; A: Apical view showing protoconch. Scale bar = 1 mm; B: Sculpture on last whorl. Scale bar = 1 mm.

lirae, rounded in cross-section, spaces equal to thickness of lirae, evenly distributed across whorls, height reduced underneath suture. Angle of aperture 30–45°, outer lip thickened, rounded, slightly to well expanded, slightly reflected, basal node usually strongly developed, parietal wall of inner lip inconspicuous.

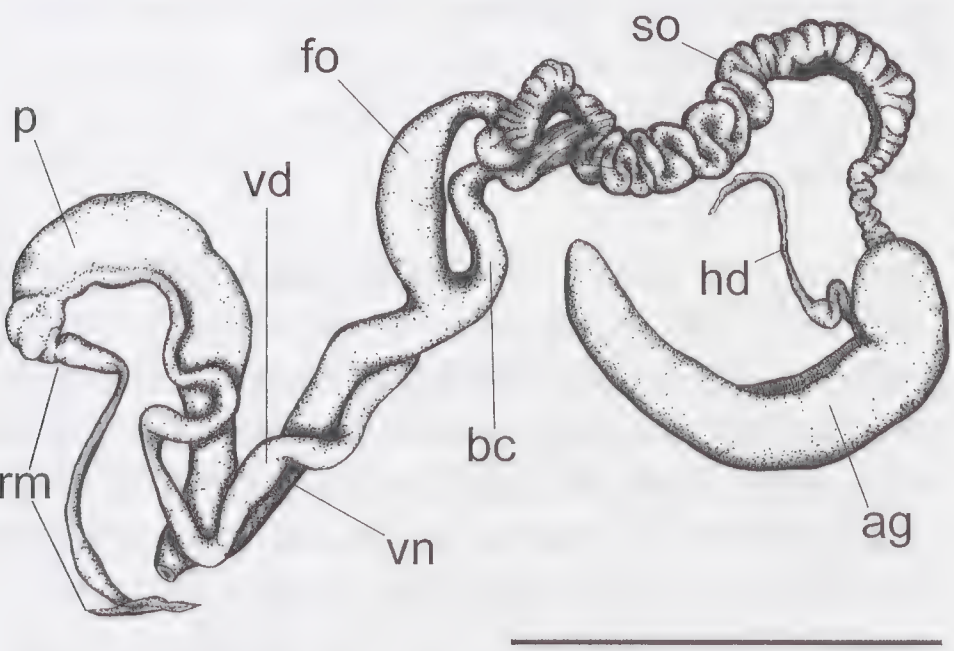


FIG. 7. Genital anatomy of *Amplirhagada burrowsena* (WAM S49355, Wargul Wargul Island; June). Scale bar = 10 mm.

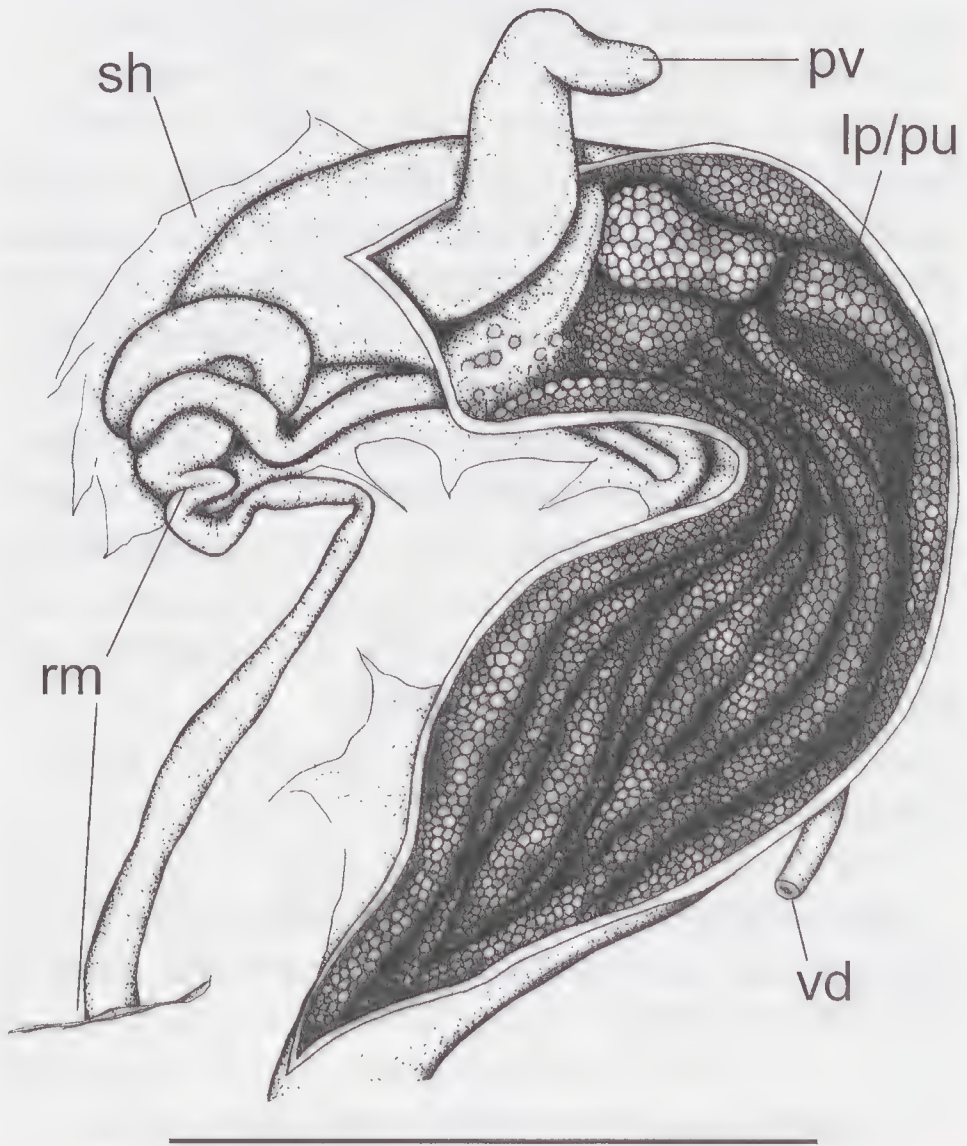


FIG. 8. Penial anatomy of *Amplirhagada burrowsena* (WAM S49355, Wargul Wargul Island; June). Scale bar = 5 mm.

Genital anatomy (Figs. 7–8): Penis curved, as long as anterior part of oviduct. Vas deferens entering sheath within distal third. Penial verge long to very long ($\sim 1/3$ of penial chamber), broad with rounded tip. Inner penial wall sculpture comprising entire length except immediately adjacent to verge, penial wall pustules small to moderate in size, densely arranged in rows; numerous corrugated longitudinal pilasters are formed by partly fused rows of elevated pustules; main stimulatory pilaster not differentiated. Inner vaginal wall pilasters formed by minute, densely arranged pustules, weak to well developed.

Mitochondrial Differentiation

Distances between conspecific samples from two different islands (Wargul Wargul and Eclipse Hill islands) (3 sequences): 0.062–0.069; interspecific distances with respect to all other congeneric species (57 sequences, 33 species): 0.179–0.230.

Comparative Remarks

Amplirhagada imitata, *A. solemiana*, *A. indistincta* and *A. burrowsena* belong to a species complex, which based in similarity in shell features was considered as a single species, *A. imitata* by Solem (1981a). All aforementioned species have similar shells with respect to colour, shape and sculpture and also exhibit largely corresponding genital anatomy (with that of topotypic populations of *A. imitata* remaining unknown). Similarity of these species is considered to reflect common ancestry and/or parallel adaptation to nearly identical environments. Shells exhibit remarkable variability within local populations. However, some distinct features can be identified with respect to shell shape and size. Shells of *A. solemiana* and, to a lesser degree, of *A. indistincta* are more depressed and smaller than those of *A. burrowsena* and *A. imitata*. *Amplirhagada burrowsena* is removed from synonymy of *A. imitata* for reasons explained in taxonomic remarks.

Distribution (Fig. 3)

Northwestern Kimberley, Bougainville Peninsula, Wargul Wargul and Eclipse Hill Island in Vansittart Bay.

Amplirhagada solemiana Köhler, 2010
Figs. 4C, 9

Amplirhagada solemiana Köhler, 2010a: 222–225, figs. 5–7.

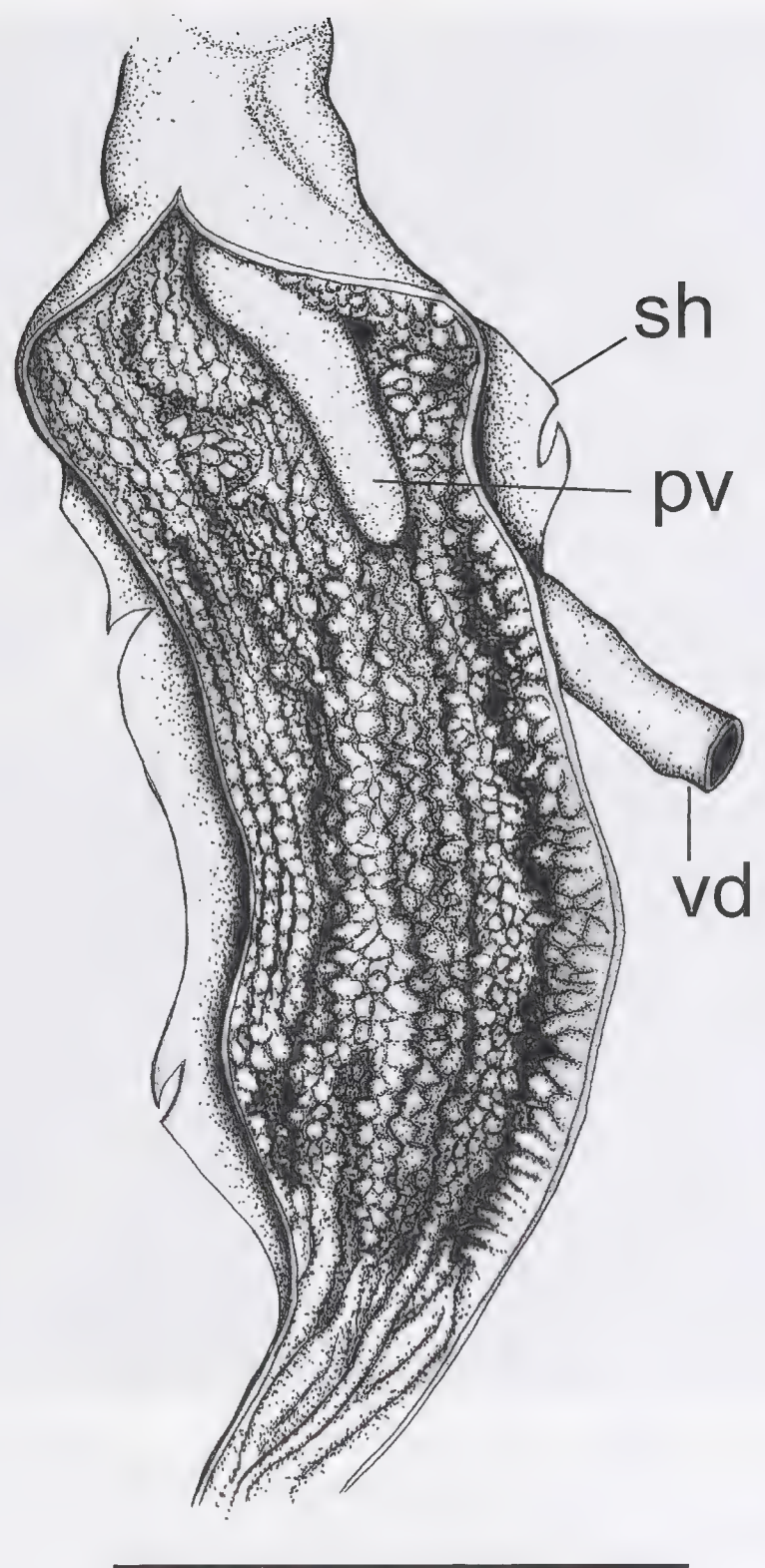


FIG. 9. Penial anatomy of *Amplirhagada solemiana* (AM C463681, Middle Osborn Island; February). Scale bar = 3 mm.

Type Locality

Western Australia, northwestern Kimberley, Bonaparte Archipelago, Admiralty Gulf, W coast of Middle Osborn Island, 14°18'18"S, 125°59'35"E.

Material Examined

Holotype WAM S34602. Paratypes AM C463681 (8 preserved specimens), WAM S36860 (20 preserved specimens) from type locality; AM C463683 (4 shells), WAM S36572 (10 shells) from 14°18'37.4"S, 125°59'18.4"E; AM C463682 (2 preserved specimens), WAM S36589 (6 preserved specimens) from east coast, 14°18'53.5"S, 126°02'06.7"E. Additional, non-type material WAM S36471, WAM S36566–71, WAM S36573, WAM S36585–99, WAM S36858, WAM S36861, WAM S36971, AM C463684–5 from Middle Osborn Island.

Diagnosis

Shell: Subglobose with moderately high spire; periphery evenly rounded to slightly angulated; umbilicus 80–90% concealed; colour horn to yellowish brown, with brown, well-defined to diffuse, moderately broad, subsutural and peripheral bands, visible on entire shell; teleoconch sculptured by coarse, regular lirae (Fig. 4C, Table 1).

Genital anatomy: Penial verge long to very long (ca. 1/3 to 1/2 of penial chamber), slender to spatulate with pointed tip. Inner penial wall with pustulation along its entire length, pustules small to moderate in size, densely arranged in rows, some of which form four to five corrugated longitudinal pilasters; main stimulatory pilaster not differentiated. Inner vaginal wall pilasters formed by minute, densely arranged pustules, weakly to well developed (Fig. 9).

Comparative Remarks

Morphologically most similar are *A. indistincta*, *A. imitata* and *A. burrowsena* (see under *A. burrowsena*). Differs from *A. imitata* and *A. burrowsena* most considerably by smaller and more depressed shell.

Distribution (Fig. 3)

Middle Osborn Island.

Amplirhagada indistincta Köhler, 2010
Figs. 4D, 10

Amplirhagada indistincta Köhler, 2010a:
225–227, figs. 10–12.

Type Locality

Western Australia, northwestern Kimberley, Bonaparte Archipelago, Admiralty Gulf, W coast of Southwest Osborn Island, 14°22'26"S, 125°56'13"E.

Material Examined

Holotype WAM S34603. Paratypes AM C463686 (5 preserved specimens), WAM S36617 (10 preserved specimens) from type locality; AM C463688 (5 shells), WAM S36575 (15 shells) from 14°22'26"S, 125°56'13"E; AM C463687 (20 preserved specimens), WAM S36865 (40 preserved specimens) from 14°22'26.5"S, 125°56'17.8"E; AM C463689 (11 shells), WAM S36962 (25 shells) from

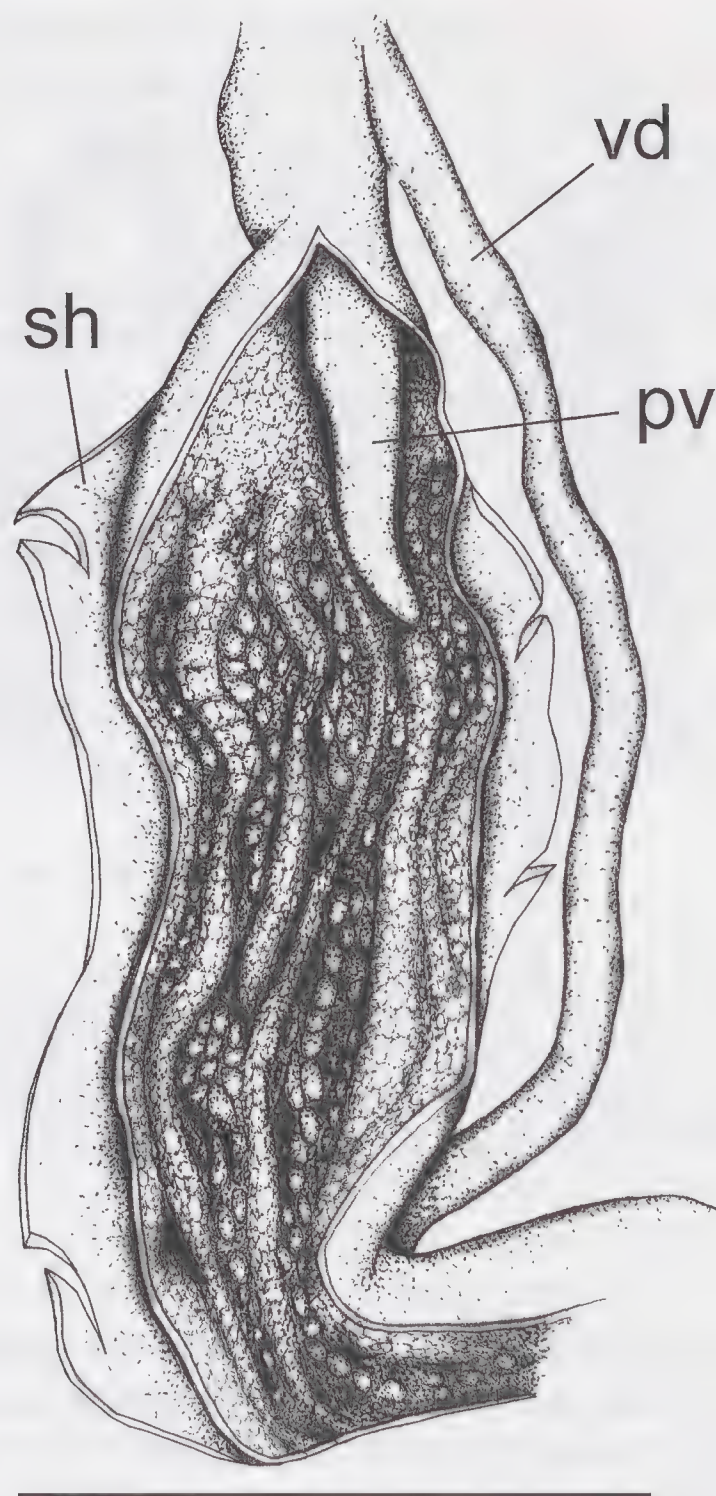


FIG. 10. Penial anatomy of *Amplirhagada indistincta* (AM C463687, Southwest Osborn Island; February). Scale bar = 5 mm.

east coast, 14°22'47.3"S, 125°56'00.6"E. Additional, non-type material WAM S28521, WAM S36491–501, WAM S36574, WAM S36577, WAM S36612–16, WAM S36618–25, WAM S36863–4, WAM S36866, AM C463690–1 from Southwest Osborn Island; WAM S41454, AM C463724 from Kidney Island, 14.329 S, 125.985 E.

Diagnosis

Shell: Subglobose to broadly conical with moderate to high spire; periphery well rounded to slightly angulated; umbilicus completely concealed. Background colour yellowish to brownish white, with thin to moderately broad brown to yellowish-brown subsutural and peripheral bands that are visible on most whorls, subsutural band diffuse, peripheral band well marked, ventral colour whitish to greyish white. Teleoconch sculptured by coarse, regular, in cross-section rounded

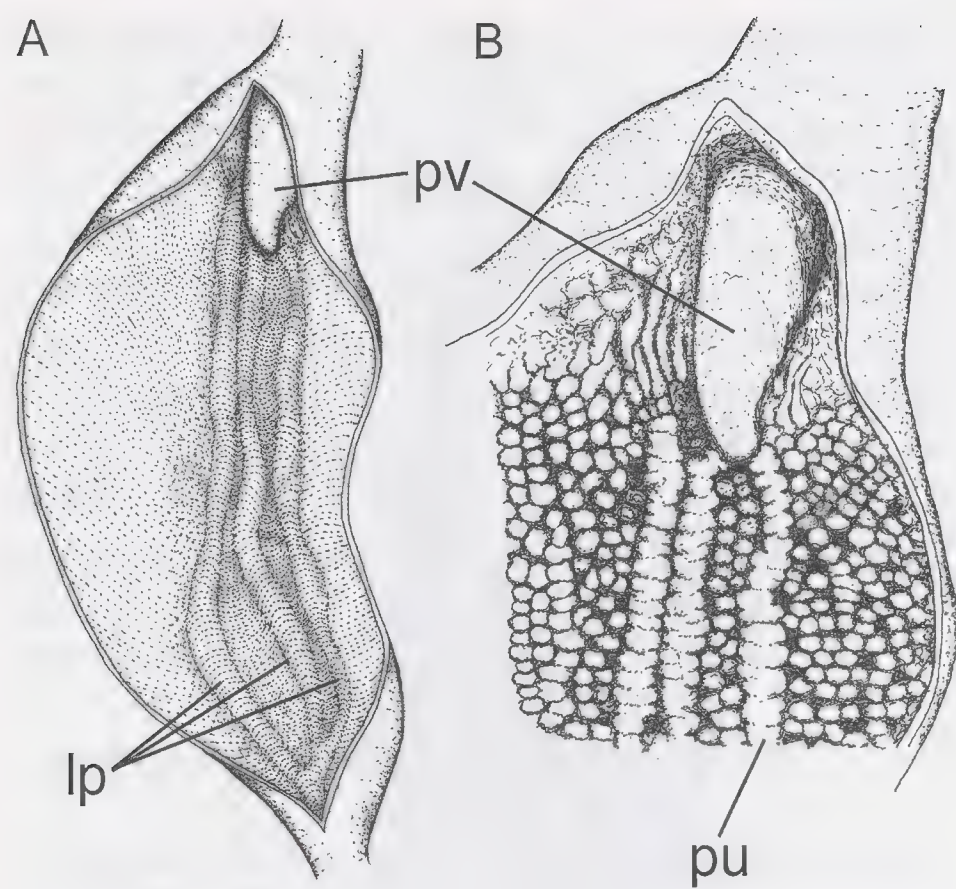


FIG. 11. Penial anatomy of *Amplirhagada katerana* (AM C463692, Katers Island; July). A: General overview of internal anatomy. Scale bar = 5 mm; B: Magnification of pustulation.

lirae, spaces between lirae equal to thickness of lirae, height reduced underneath suture (Fig. 4D, Table 1).

Genital anatomy: Penial verge long to very long (ca. 1/3 to 1/2 of penial chamber), slender to spatulate with pointed tip. Pustulation comprising entire length of inner penial wall; penial wall pustules small to moderate in size, densely arranged in rows, some of which form four to five longitudinal pilasters along entire length of penial chamber; main stimulatory pilaster not differentiated. Vas deferens entering penial sheath apically. Inner vaginal wall pilasters formed by minute, densely arranged pustules, weakly to well developed (Fig. 10).

Comparative Remarks

Morphologically most similar are *A. solemiana*, *A. imitata* and *A. burrowsena* (see under *A. burrowsena*). Differs from *A. imitata* and *A. burrowsena* most considerably by more depressed shell, from *A. solemiana* by larger size. In addition, *A. solemiana* and *A. indistincta* are genetically well differentiated (Köhler, 2010a). Specimens from Kidney Island, which is located in between Middle and Southwest Osborn islands, have slightly larger and more robust shells than specimens from the type locality.

Distribution (Fig. 3)

Southwest Osborn and Kidney islands.

Amplirhagada katerana Solem, 1981 Figs. 4A, 11

Amplirhagada katerana Solem, 1981a: 198–201, figs. 37d, 41a, 43e, f; Köhler, 2010a: 236–238, figs. 27–29.

Type Locality

Western Australia, northwestern Kimberley, Bonaparte Archipelago, Montague Sound, Katers Island.

Material Examined

AM C463692, AM C463695–6, WAM S36601, WAM S36878–80 (preserved specimens) from Katers Island, 14°26'49–52"S, 125°31'07–15"E (Fig. 1).

Diagnosis

Shell: Subglobose; periphery evenly rounded to angulated; umbilicus forming 80–95% concealed. Background colour horn, with diffuse to well-marked, dark brown, moderately to very thick subsutural and peripheral bands; bands may blend into each other concealing background colour, ventral colour, outer and inner lip horn. Teleoconch rather smooth, with regular axial growth lines (Fig. 4E, Table 1).

Genital anatomy: Penial verge short (1/8–1/4 of penial chamber), broad, with pointed tip. Inner penial wall entirely covered with small pustules, arranged in rows over entire length of wall; three pilasters formed by rows of thickened, partly fused pustules (Fig. 11).

Comparative Remarks

Shell more conical and whorls more flattened in diameter than in species treated before. Dark brown colour of most shells with pronounced different ventral colour is also characteristic. Penial interior with three longitudinal pilasters formed by enlarged wall pustules is typical for this species only. For comparison with other species, see Solem (1981a: 198–199).

Distribution (Fig. 3)

Katers Island.

Amplirhagada decora Köhler, 2010 Figs. 4F, 12

Amplirhagada decora Köhler, 2010a: 240–242, figs. 33–35.

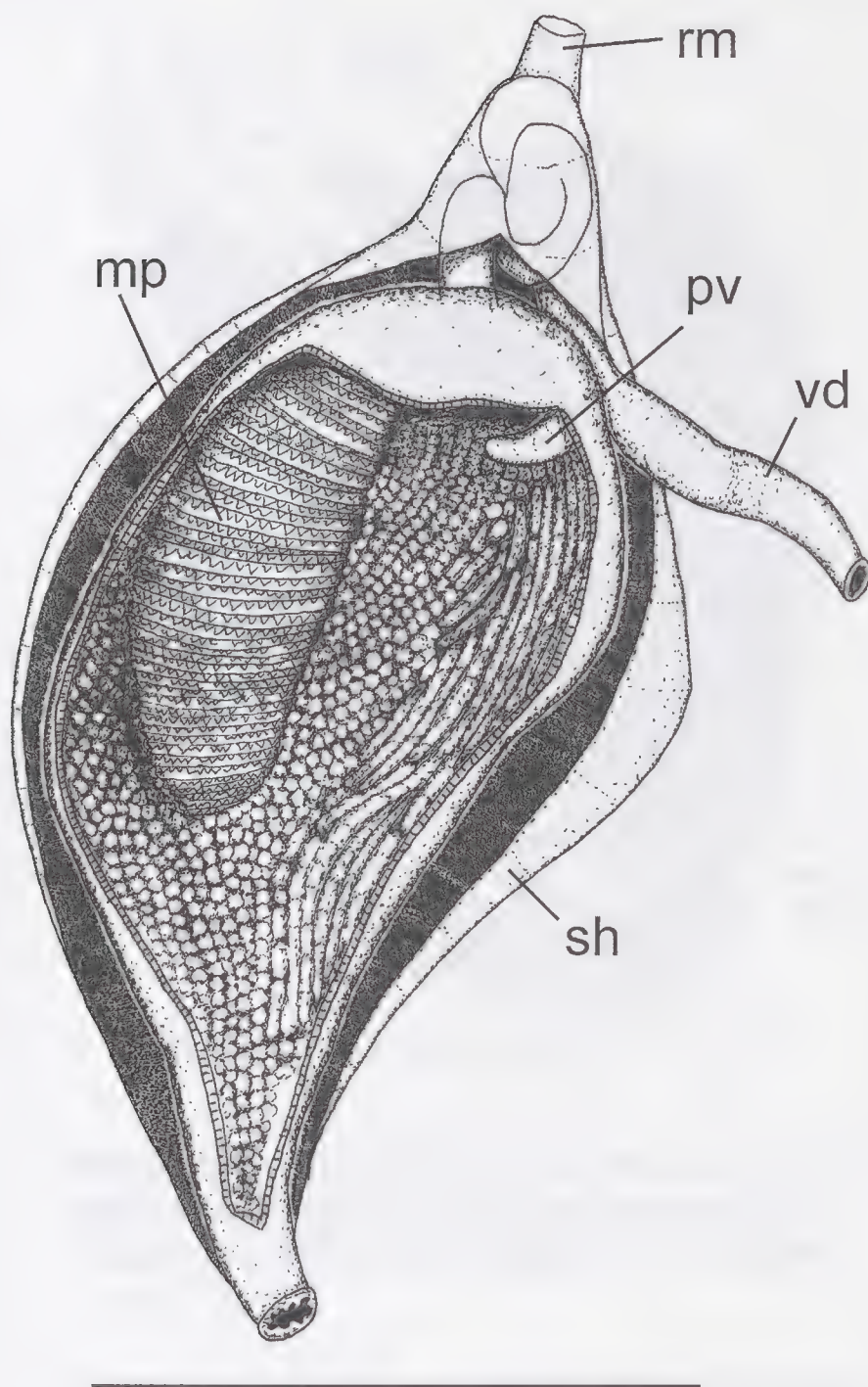


FIG. 12. Penial anatomy of *Amplirhagada decora* (AM C463698, Bigge Island; February). Scale bar = 5 mm.

Type Locality

Western Australia, northwestern Kimberley, Bonaparte Archipelago, Bigge Island, 4.3 km N of Savage Hill, 14°35'15"S, 125°11'05"E.

Material Examined

Holotype WAM S34609 (Fig. 4F). Paratypes AM C463698 (8 preserved specimens), WAM S36873 (17 preserved specimens) from type locality; AM C463699 (4 preserved specimens), WAM S36874 (9 preserved specimens) from 14°35'13.3"S, 125°11'10.5"E; AM C463700 (shell), WAM S36963 (2 shells) from 14°35'15"S, 125°11'05"E. Additional, non-type material WAM S36461–7, WAM S36652–4, WAM S36872 from Bigge Island.

Diagnosis

Shell: Broadly conical to subglobose, with medium to high spire; periphery angulated; upper sector of whorls flattened to rounded;

umbilicus completely concealed; brownish horn with well-defined, dark brown, moderately broad subsutural and peripheral bands, most conspicuous on last whorls. Teleoconch sculptured with fine axial lirae, rounded in cross-section, evenly across shell surface, reduced underneath suture (Fig. 4F, Table 1).

Genital anatomy: Penial verge tiny. Inner penial wall with pustules of average size, densely arranged in rows over entire length of inner penial wall, partly fused to small elongated ridges; main stimulatory pilaster well-differentiated, forming a very large cone sculptured by dense ridges comprising apical to median portion of penial chamber; pilaster ridges with tiny hooks (Fig. 12).

Comparative Remarks

Dome-shaped shell as found only in some species, amongst which *A. decora* is one of the smallest and tallest (H/D larger than in most species). Conspicuous spiral banding is also typical; only *A. berthierana* Köhler, 2010, has a similarly shaped and coloured shell being on average larger in diameter. Rather large pustules of inner penial wall in combination with large, cone-shaped main pilaster with densely arranged hooks and tiny verge are diagnostic for *A. decora*; *A. berthierana* with smooth main stimulatory pilaster and larger verge.

Distribution (Fig. 3)

Bigge Island, in sympatry with *A. kessneri*.

Amplirhagada kessneri Köhler, 2010
Figs. 4G, 13

Amplirhagada kessneri Köhler, 2010a: 242–243, figs. 36–38.

Type Locality

Western Australia, northwestern Kimberley, Bonaparte Archipelago, Bigge Island, 4.3 km N of Savage Hill, 14°35'15"S, 125°11'05"E.

Material Examined

Holotype WAM S34610 (Fig. 4G). Paratypes AM C463701 (4 preserved specimens), WAM S36875 (10 preserved specimens) from type locality; AM C463702 (9 preserved specimens), WAM S36477 (5 shells), AM C463703 (2 shells), WAM S36658 (10 preserved specimens) from 14°35'16"S, 125°11'02"E; WAM S36876 (16 preserved specimens) from 14°35'18.5"S, 125°10'54.7"E.

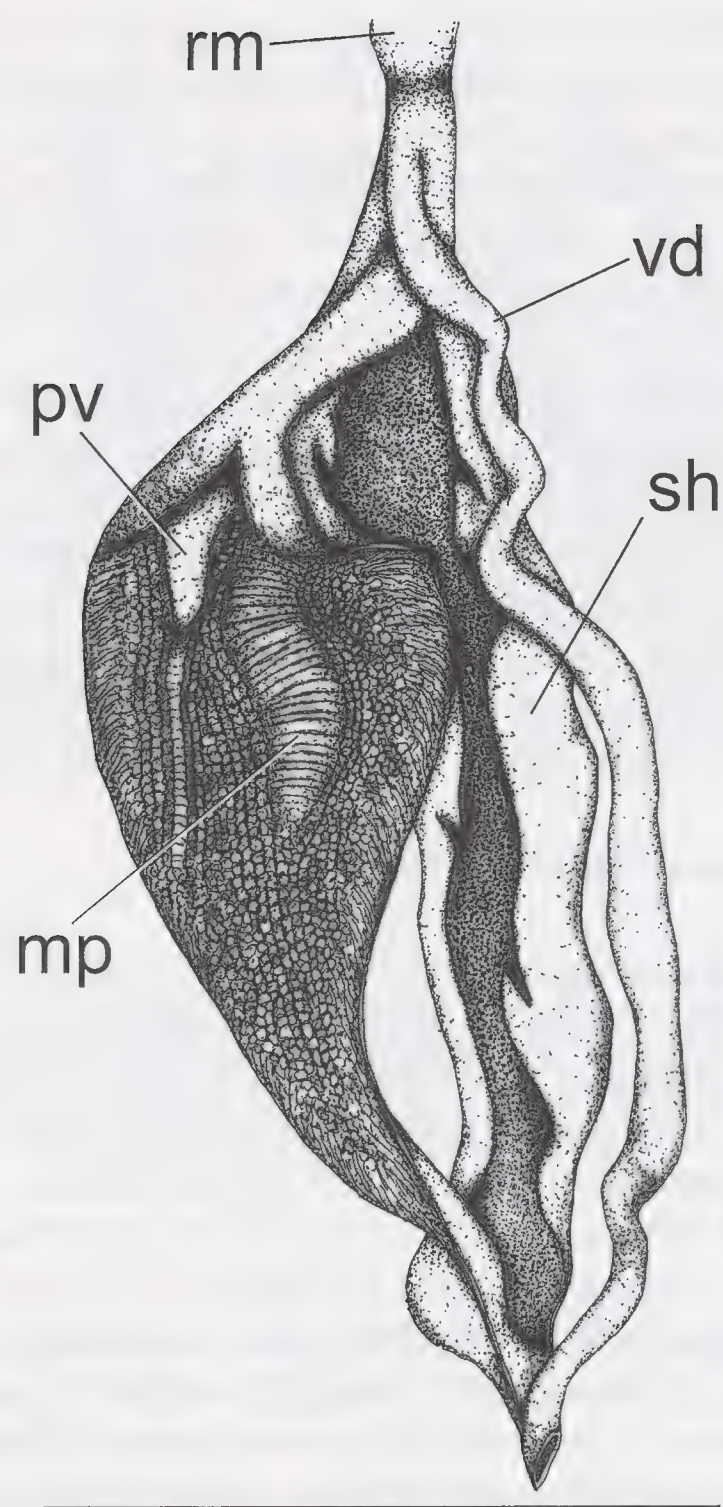


FIG. 13. Penial anatomy of *Amplirhagada kessneri* (WAM S36875, Bigge Island; February). Scale bar = 3 mm.

Diagnosis

Shell: Subglobose to conical with low spire; periphery evenly rounded to angulated; umbilicus forming a chink or open, 30–90% concealed; horn to light brown, exceptionally dark brown, brown subsutural and peripheral bands absent or diffuse to well marked, thin to moderately thick, most conspicuous on last whorls. Teleoconch sculptured with regularly spaced axial lirae becoming somewhat oblique on last whorl (Fig. 4G, Table 1).

Genital anatomy: Penial verge short ($< 1/8$ penial chamber), slender to spatulate, with truncated tip; penial wall pustules small, densely arranged in rows over entire length of inner penial wall; main stimulatory pilaster well differentiated, forming a large, elongated cone, sculptured by smooth horizontal ridges, on apical to median portion of penial chamber (Fig. 13).

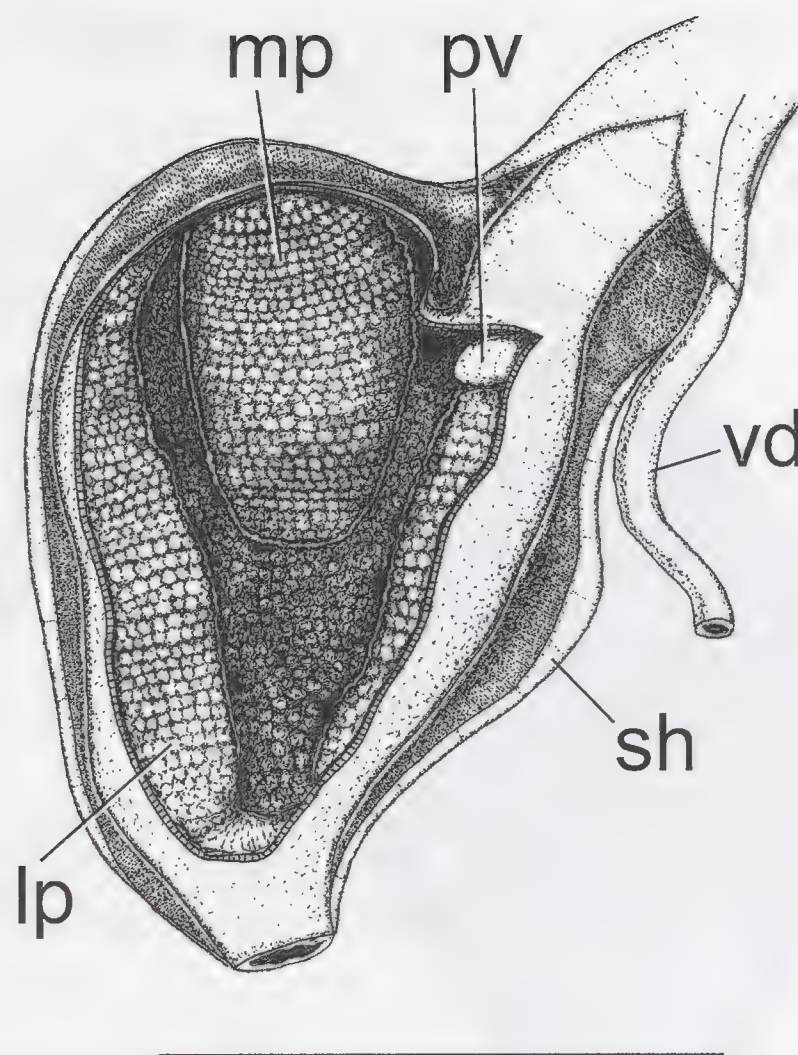


FIG. 14. Penial anatomy of *Amplirhagada boongareensis* (WAM S36655, Boongaree Island; August). Scale bar = 5 mm.

Comparative Remarks

Differs from most species by flatter, conspicuously angulated and uniformly reddish brown shell. From *A. decora* (also from Bigge Island), it also differs by a much smaller main pilaster and finer pustulation of inner penial wall.

Distribution (Fig. 3)

Bigge Island, in sympatry with *A. decora*.

Amplirhagada boongareensis Köhler, 2010
Figs. 4H, 14

Amplirhagada boongareensis Köhler, 2010a:
253–355, figs. 54–56.

Type Locality

Western Australia, Kimberley, Bonaparte Archipelago, central section of Boongaree Island, 15°04'36"S, 125°11'12"E.

Material Examined

Holotype WAM S34616 (Fig. 4H). Paratypes WAM S36655 (3 preserved specimens) from type locality; AM C463707 (8 shells), WAM S36455 (12 shells), WAM S36456 (15 shells)

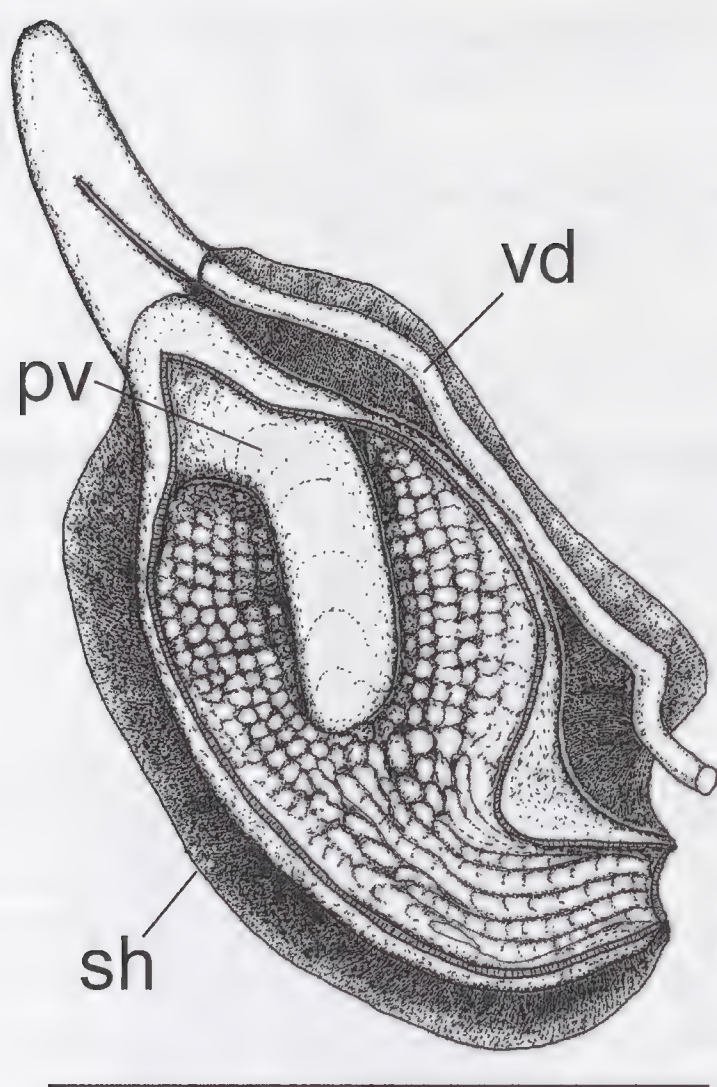


FIG. 15. Penial anatomy of *Ampirhagada gibsoni* (AM C463709, Boongaree Island; August). Scale bar = 5 mm.

from 15°04'31"S, 125°11'07"E; AM C463706 (6 shells), WAM S36458 (8 shells) from 15°04'16"S, 125°10'47"E; WAM S36656 (preserved specimens) from 15°04'09"S, 125°10'49"E.

Additional, non-type material WAM S36457, WAM S36459–60 from Boongaree Island.

Diagnosis

Shell: Beehive-shaped, with high spire; periphery slightly to clearly angulated; upper sector of whorls slightly shouldered, basal sector rounded; umbilicus 50–100% concealed; light brown, subsutural and peripheral bands may be absent or, if present diffuse to well marked, dark reddish brown, thin to moderately broad, most conspicuous on last whorl, bands may blend into each other covering entire surface of tip of shell with purplish brown colour; inner lip colour blends from reddish brown near parietal wall into horn at outer sections. Teleoconch with regular, fine axial lirae, rounded in cross-section, evenly distributed across shell surface, reduced in prominence underneath suture (Fig. 4H, Table 1).

Genital anatomy: Penial verge barely visible; penial wall pustules of average size, dense, randomly arranged across entire length of inner penial wall; main stimulatory pilaster well-differentiated, large, cone-shaped, covered by smooth, flattened pustules arranged in horizon-

tal rows, comprising apical to median portion of penial chamber; two additional pilasters form along entire length of penial chamber covered by undifferentiated pustulation (Fig. 14).

Comparative Remarks

In proportion the tallest of all species ($H/D < 1.12$), *A. boongareensis* is characterized by its conspicuously high, beehive-shaped shell and its dark purplish-brown colour. Its heavily sculptured inner penial wall, which supports a very large main stimulatory pilaster, differs conspicuously from other species with dome-shaped shells, which frequently exhibit a smooth or simple penial wall sculpture without pustulation.

Distribution (Fig. 3)

Boongaree Island, in sympatry with *A. gibsoni*, *A. regia* and presumably another undescribed *Ampirhagada* species.

Ampirhagada gibsoni Köhler, 2010
Figs. 4I, 15

Ampirhagada gibsoni Köhler, 2010a: 255–256, figs. 57–59.

Type Locality

Western Australia, Kimberley, Bonaparte Archipelago, central section of Boongaree Island, 15°04'15"S, 125°11'14"E.

Material Examined

Holotype WAM S34617 (Fig. 4I). Paratypes AM C463709 (preserved specimen), WAM S36650 (2 preserved specimens) from type locality; AM C463708 (4 shells) from 15°04'15"S, 125°11'14"E; WAM S36468 (6 shells) from 15°04'36"S, 125°11'18"E; WAM S36469 (10 shells), WAM S36651 (preserved specimen) from 15°04'36"S, 125°11'18"E.

Diagnosis

Shell: Subglobose to conical with medium high spire; periphery evenly rounded to slightly angulated; upper and basal sectors of whorls rounded; umbilicus forming a chink or 90% concealed; uniformly light brownish to horn; inner lip white. Teleoconch sculptured with regular, fine axial lirae, rounded in cross-section, evenly distributed across shell surface, reduced underneath suture (Fig. 4I, Table 1).

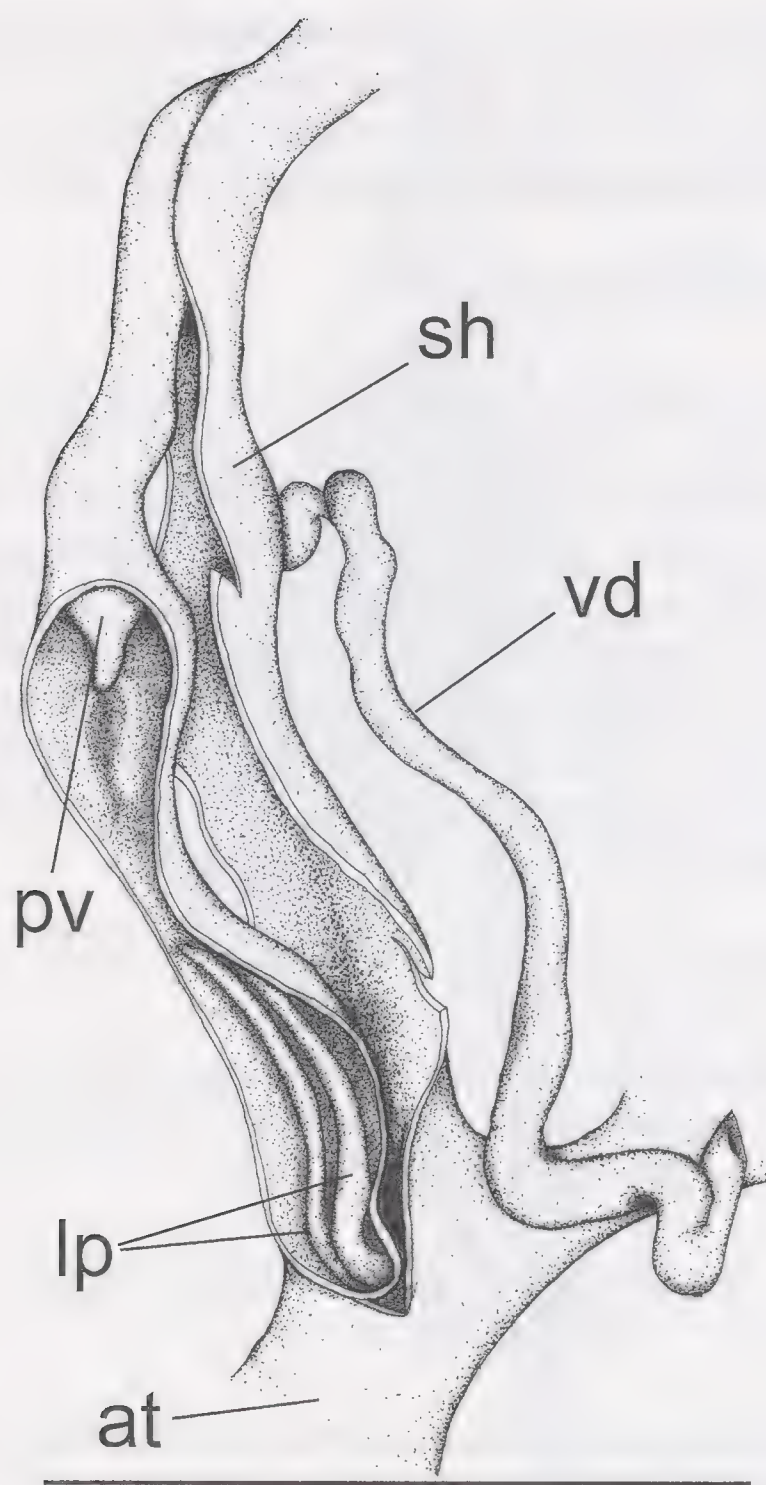


FIG. 16. Penial anatomy of *Amplirhagada regia* (WAM S36647, Boongaree Island; August). Scale bar = 5 mm.

Genital anatomy: Penial verge very long (ca. 1/3 penial chamber), broad, with pointed tip; penial wall pustules of normal size, randomly and densely arranged across entire length of inner penial wall, at base of penial chamber rows of fused pustules form 3–4 smooth longitudinal pilasters; main stimulatory pilaster absent (Fig. 15).

Comparative Remarks

Shell smaller in size, not as elevated in shape as in congeners from same island. Large pustules and very large penial verge are diagnostic.

Distribution (Fig. 3)

Boongaree Island, in sympatry with *A. boongareensis*, *A. regia* and presumably another undescribed *Amplirhagada* species.

Amplirhagada regia Köhler, 2010
Figs. 4J, 16

Amplirhagada regia Köhler, 2010a: 251–253, figs. 51–53.

Type Locality

Western Australia, Kimberley, Bonaparte Archipelago, central section of Boongaree Island, 15°04'15"S, 125°11'14"E.

Material Examined

Holotype WAM S34615 (Fig. 4J). Paratypes AM C463705 (4 preserved specimens), WAM S36647 (3 preserved specimens) from type locality; WAM S36449 (6 preserved specimens) from 15°04'00"S, 125°11'11"E; AM C463704 (6 shells), WAM S36480 (12 shells) from 15°04'31"S, 125°11'07"E.

Additional, non-type material WAM S36479, WAM S36481–5, WAM S36648 from Boongaree Island.

Diagnosis

Shell: Globose with medium high to high spire, solid to thick, periphery angulated, upper sector of whorls rather flattened, basal sector rounded, umbilicus 60–100% concealed; colour uniformly cremish horn, outer lip purple, inner lip pale purple. Teleoconch smooth, except faint axial growth lines (Fig. 4J, Table 1).

Genital anatomy: Penial verge short (< 1/8 penial chamber), slender to spatulate, with pointed tip; penial wall smooth, with two longitudinal pilasters at basal portion of penial chamber, plus two weakly developed pilasters at apical portion (Fig. 16).

Comparative Remarks

Diagnostic features are broadly conical to dome-shaped shell, smooth inner penial wall with lack of pustulation and main pilaster (penial wall sculpture differs conspicuously from sympatric congeners; see above).

Distribution (Fig. 3)

Boongaree Island, in sympatry with *A. boongareensis*, *A. gibsoni* and presumably another undescribed *Amplirhagada* species.

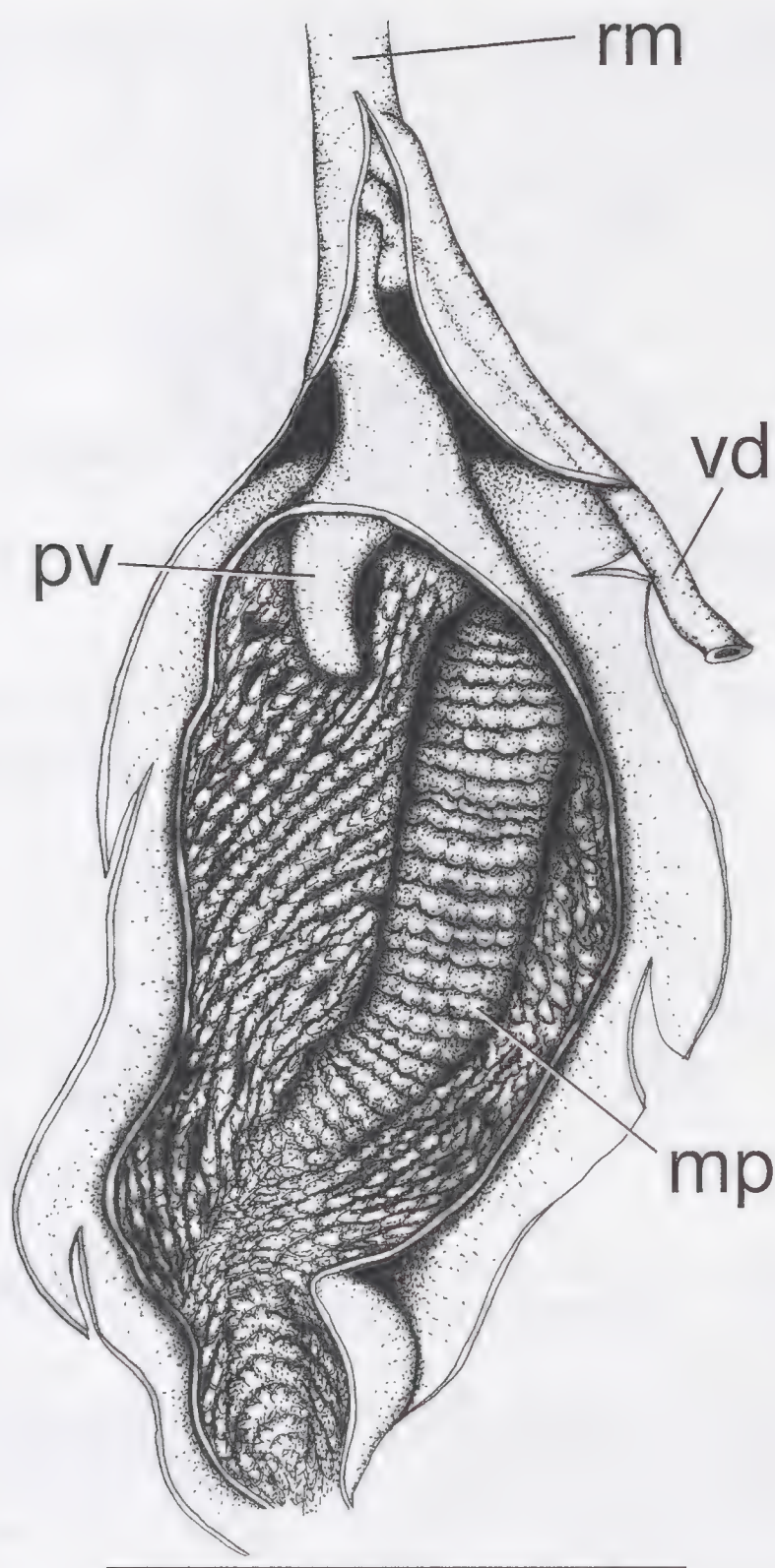


FIG. 17. Penial anatomy of *Amplirhagada yorkensis* (AM C463711, Coronation Island; May). Scale bar = 3 mm.

Amplirhagada yorkensis Köhler, 2010
Figs. 4L, 17

Amplirhagada yorkensis Köhler, 2010a: 257–259, figs. 61–63.

Type Locality

Western Australia, central Kimberley coast, Bonaparte Archipelago, York Sound, southern section of Coronation Island, 15°01'52"S, 124°56'56"E.

Material Examined

Holotype WAM S34619. Paratypes AM C463711 (24 preserved specimens), WAM S36979 (42 preserved specimens).

Additional, non-type material WAM S37376–8, WAM S36980–6, WAM S37394–404, AM C463712–4 (Coronation Island, southern and northern sections).

Diagnosis

Shell: Broadly conical with low spire, periphery evenly rounded to slightly angulated, upper and basal sectors of whorls rounded, umbilicus open, 30–90% concealed; brownish horn, sub-sutural band absent, peripheral band absent or diffuse, light yellowish brown, thin, only visible on last whorl(s). Teleoconch smooth except axial growth lines (Fig. 4L, Table 1).

Genital anatomy: Penial verge very short; penial wall pustules of average size, arranged in rows across entire length of inner penial wall; main stimulatory pilaster well-differentiated, large, cone-shaped, sculptured by horizontal ridges that support little hooks, comprising about 3/4 of length of penial chamber (Fig. 17).

Comparative Remarks

Typical for this species is comparatively small, low-spined shell, well-rounded periphery and pale colour; penis with a comparatively large main pilaster.

Distribution (Fig. 3)

Coronation Island. Potentially also on adjacent islands and islets and the adjacent mainland.

Amplirhagada uwinsensis Köhler, 2010
Figs. 4M, 18–19

Amplirhagada uwinsensis Köhler, 2010a: 261–263, figs. 67–69.

Type Locality

Western Australia, central Kimberley coast, Bonaparte Archipelago, Hanover Bay, Uwins Island, 15°15'32"S, 124°46'08"E.

Material Examined

Holotype WAM S34621. Paratypes AM C463715 (15 preserved specimens), WAM S36991 (35 preserved specimens) from type locality; AM C463716 (15 shells), WAM S37441 (30 shells) from 15°15'25"S, 124°48'04"E.

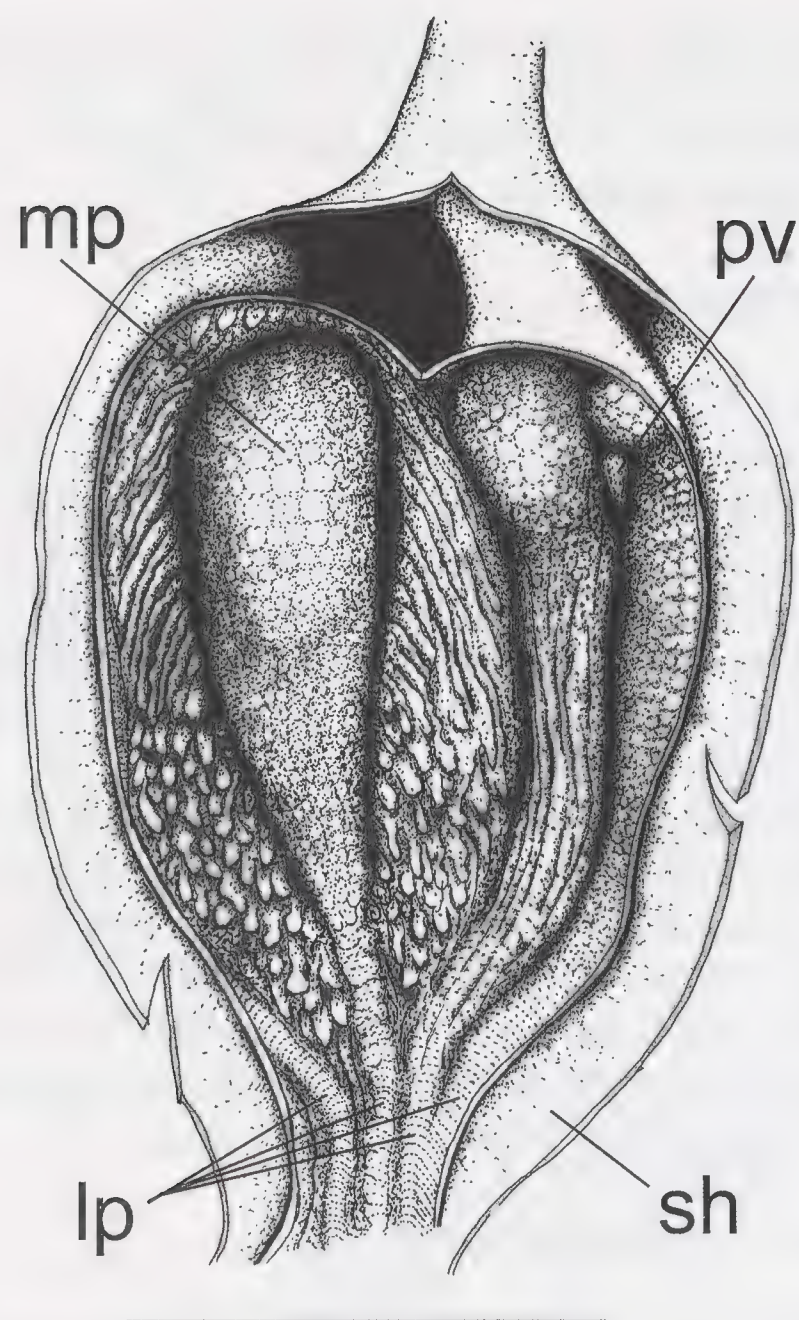


FIG. 18. Penial anatomy of *Amplirhagada uwinsensis* (AM C463715, Uwins Island; August). Scale bar = 5 mm.

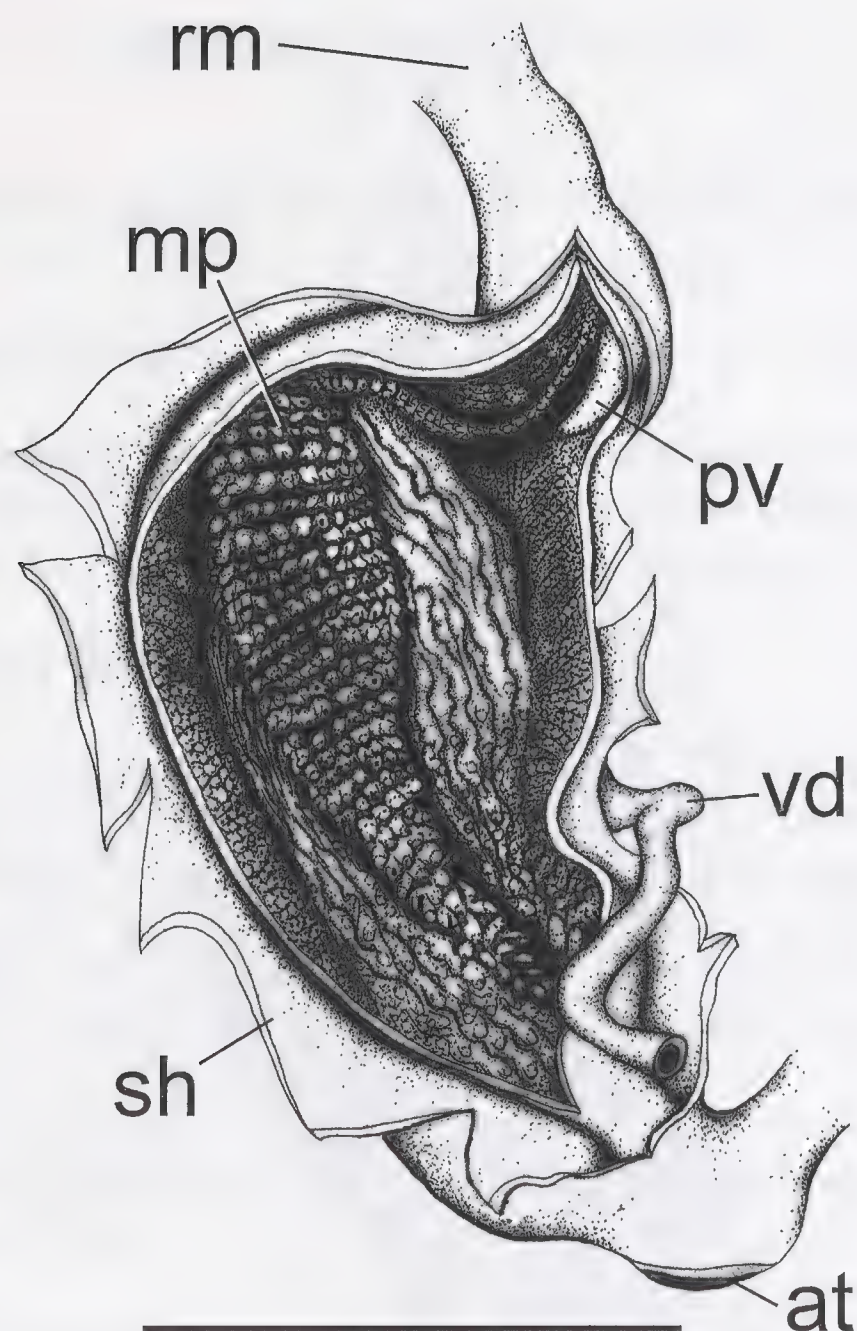


FIG. 19. Penial anatomy of *Amplirhagada uwinsensis* (FMNH 2219102, Myctiys Island; August). Scale bar = 5 mm.

Additional, non-type material AM C463717, WAM S36987–90, WAM S37440, WAM S37442–4, from Uwins Island; AM C471712 (20 preserved specimens), WAM S37664 (51 preserved specimens) from Mictiys Island, 2.5 km NW of Uwins Island; 15°13'12"S, 124°47'23"E; FMNH 219102 from Mictiys Island, 15°13'05"S, 124°47'20"E.

Diagnosis

Shell: Subglobose, beehive-shaped, with medium high spire; periphery angulated; upper and basal sectors of whorls rounded; umbilicus completely concealed; light reddish brown with light to chestnut brown, diffuse to well-defined subsutural and peripheral band, bands may blend into each other covering entire surface, outer lip blending into chestnut brown, inner lip blending into dark ochre to chestnut brown. Teleoconch with marked radial growth lines becoming oblique towards base of shell (Fig. 4M, Table 1).

Genital anatomy: Penial verge barely visible; penial wall pustules comparatively large, elon-

gated, arranged in rows on median and basal portion of penial chamber, forming densely packed, narrow longitudinal pilasters at apical end of penial chamber; main stimulatory pilaster well-differentiated, large, cone-shaped, covered with flattened pustules, comprising distal to median portion of penial chamber; two additional pilasters form along wall, covered by flattened pustules or smooth narrow ridges (Figs. 18, 19).

Comparative Remarks

One of the species with large, dome-shaped shells; conspicuously differing from *A. tricenaria* Köhler, 2010, and *A. regia* by dark brown outer lip colour and huge, cone-shaped main pilaster, presence of additional pilasters and characteristically elongated pustules of inner penial wall. Material from Mictiys Island kept in FMNH was identified by Solem as "*Amplirhagada* NSP 66" exhibits identical genital anatomy (only differing by presence of little hooks on main pilaster) (Fig. 19), and is considered as conspecific. A sample of immature specimens from adjacent

mainland (WAM S37669, 1.3 km S of Halfway Bay, 15°20'15"S, 124°49'23"E) is differentiated by 3% uncorrected genetic p-distance in 16S; for immature state of specimens, species identity remains questionable.

Distribution (Fig. 3)

Uwins and Mictyis islands.

Amplirhagada sphaeroidea Köhler, 2010
Figs. 4N, 20

Amplirhagada sphaeroidea Köhler, 2010a:
263–264, figs. 70–72.

Type Locality

Western Australia, central Kimberley coast, Saint George Basin, St. Andrews Island, 15°21'24"S, 124°59'46"E.

Material Examined

Holotype WAM S34622 (Fig. 4N). Paratypes AM C463718 (2 preserved specimens), WAM S37029 (7 preserved specimens) from type locality; AM C463719 (shell), WAM S37027 (3 preserved specimens), WAM S37411 (shell) from 15°21'34"S, 125°00'07"E). Additional, non-type material WAM S37028, WAM S37030, WAM S37410–12, WAM S49000–1 from St. Andrews Island.

Diagnosis

Shell: Globose to subglobose, beehive-shaped, with medium high spire; solid to thick; periphery angulated; upper sector of whorls rather flattened, basal sector rounded; umbilicus 90–100% concealed; colour blends from horn at base to lightly brownish at top of shell, subsutural and peripheral bands absent or diffuse, brownish, visible on last whorl(s) only; ventrally crème; outer lip dark brownish-purple; inner lip blending from dark pink outside to horn deeper inside. Teleoconch smooth except faint growth lines (Fig. 4N, Table 1).

Genital anatomy: Penial verge short (< 1/8 penial chamber), slender with pointed tip; penial wall pustules fused, forming regular, smooth, diagonal, delicate lamellae on apical portion, becoming more and more oblique towards anterior end of penial chamber; main stimulatory pilaster elongated, large, cone-shaped, corrugated, comprising apical portion

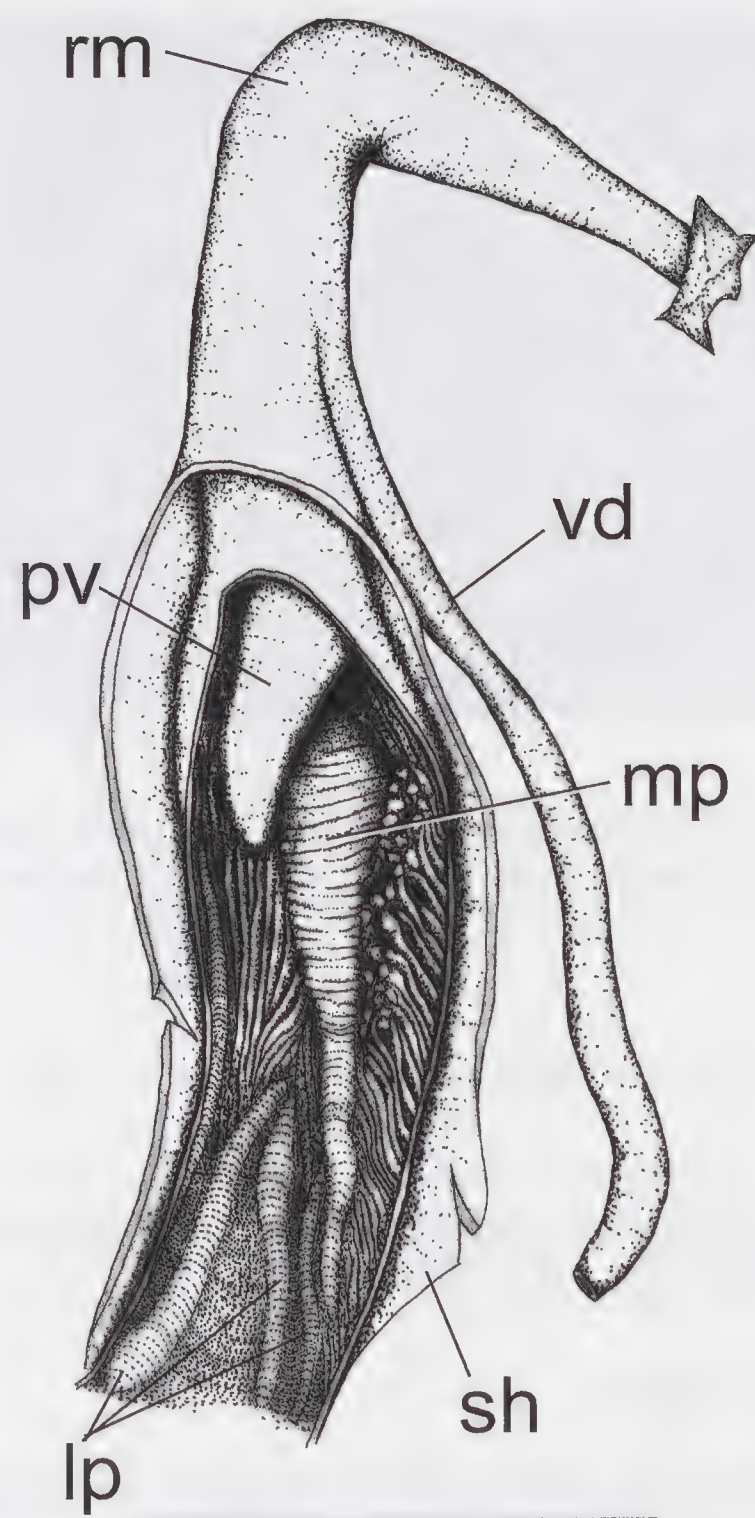


FIG. 20. Penial anatomy of *Amplirhagada sphaeroidea* (WAM S37027, St. Andrews Island; May). Scale bar = 3 mm.

of penial chamber and gradually decreasing in size anteriorly; three additional, smooth, narrow, rather indistinct pilasters form at anterior base of penial chamber (Fig. 20). Vas deferens entering penial sheath apically.

Comparative Remarks

One of the few species with large, dome-shaped shells; differing from *A. tricenaria* and *A. regia* by dark outer lip and from *A. uwinsensis* by purplish colour of outer lip. Covering of inner penial wall with lamellae, elongate-conical, corrugated main pilaster, and relatively large verge are diagnostic.

Distribution (Fig. 3)

St. Andrews Island, in sympatry with *A. cf. pusilla* Solem, 1981.

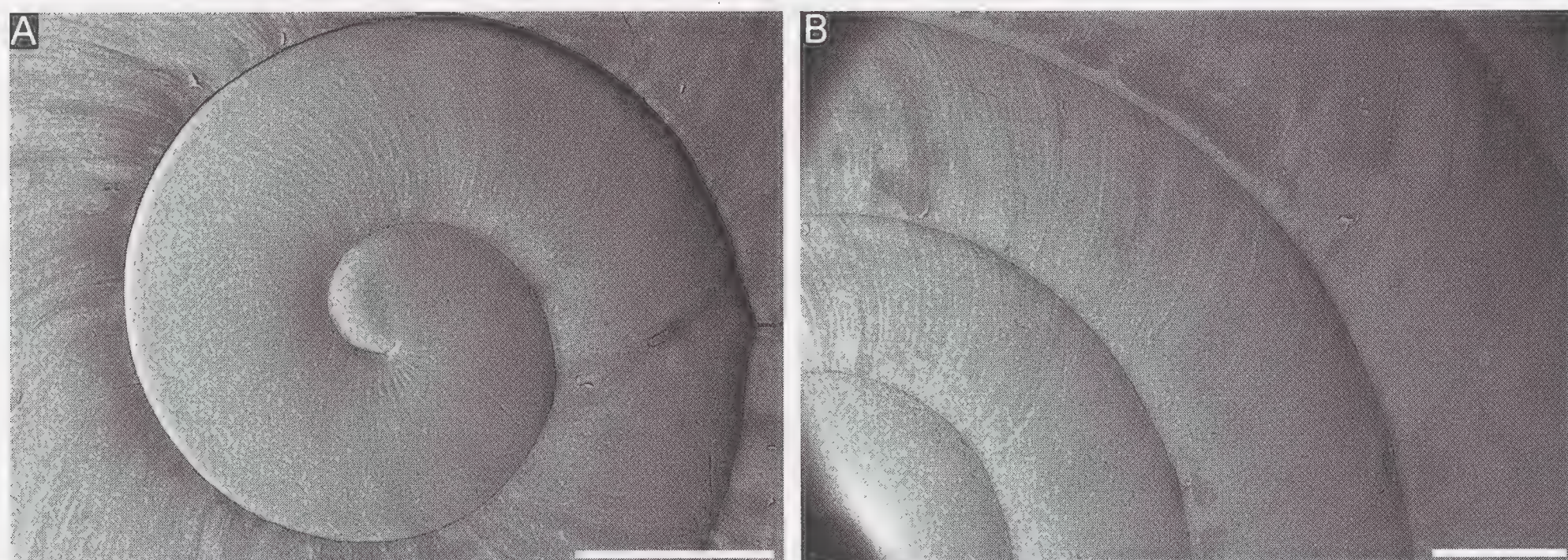


FIG. 21. SEM micrographs of the shell of *Amplirhagada globosa* n. sp. paratype AM C471713 (St. Patrick Island). A: Apical view showing protoconch; B: Sculpture on first four whorls viewed from above. Scale bars = 1 mm.

Amplirhagada cf. *pusilla* Solem, 1981
Fig. 4O

Amplirhagada pusilla Solem, 1981a: 194–198,
pl. 12c, figs. 37c, 38e, f, 41b, 42.

Type Locality

Western Australia, northwestern Kimberley,
Prince Regent Reserve, Pitta Creek Gorge.

Material Examined

WAM S37405–9 (shells) from St. Andrew
Island, 15°21'26–36"S, 124°59'41–52"E.

Diagnosis

Shell: Comparatively small, broadly conical with rather low spire and sharply angulated periphery; last whorl weakly descending before aperture; umbilicus open, 0–50% concealed; background colour pale (whitish) with well-developed, narrow, slightly diffuse brown spiral band slightly above periphery; subsutural band inconspicuous. Teleoconch sculptured by radial growth lines, surface somewhat glossy; aperture simple rounded, apertural lip slightly thickened, expanded, slightly reflected; basal node weakly developed (Fig. 4O, Table 1).

Comparative Remarks

Only dry shells available, which correspond well with Solem's (1981a) description of *A. pusilla*. This species is characterised by rather

small, flat shell ($H/D \sim 0.59$) with open umbilicus. However, shells alone do not permit unequivocal identification of species deeming the current determination provisional. *Amplirhagada yorkensis* is similar in shell size and shape but has a wider umbilicus, not as well-developed spiral bands.

Distribution (Fig. 3)

Upper Prince Regent Reserve; possibly including St. Andrews Island.

Amplirhagada globosa n. sp.
Figs. 4P, 21–23

Type Locality

Western Australia, central Kimberley coast, Saint George Basin, St. Patrick Island; 15°21'23"S, 124°57'55"E; coll. Vince Kessner, 9/02/2009, KIS 2–64 (Vine thicket on steep slopes, sandstone boulders. Resting on trees and boulders).

Material Examined

Holotype WAM S58432 (preserved specimen; Fig. 4P). Paratypes WAM S37665 (25 preserved specimens), AM C471713 (10 preserved specimens), AM C471714 (6 shells) WAM S37999 (10 shells), from type locality.

Etymology

From "*globosa*" (Latin = round, spherical, globular) referring to its globose shell; adjective of feminine gender.

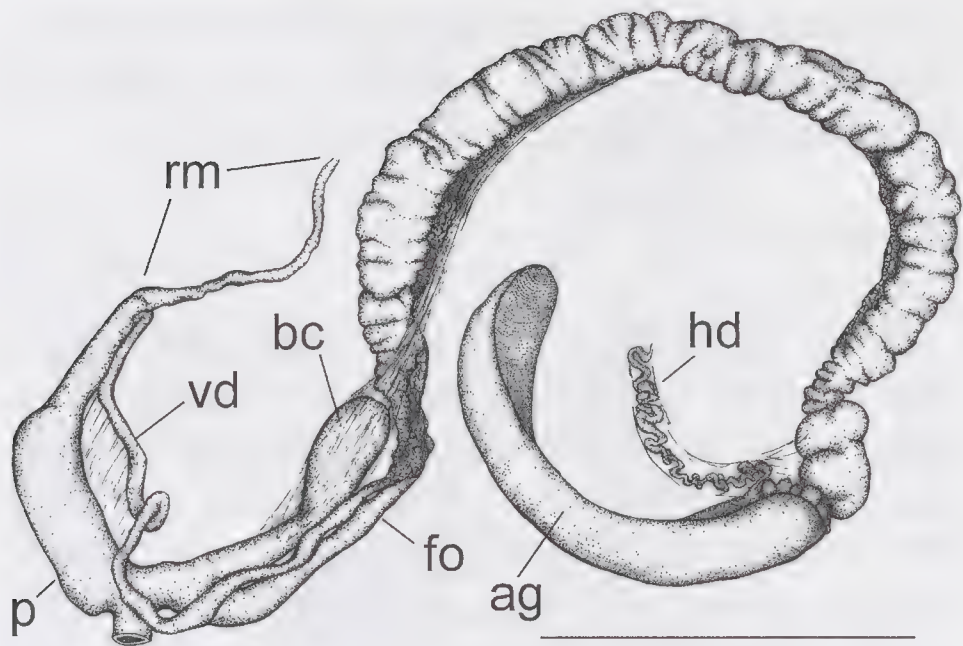


FIG. 22. Genital anatomy of *Amplirhagada globosa* n. sp. paratype AM C471713 (St Patrick Island; February). Scale bar = 10 mm.

Description

Shell (Figs. 4P, 21; Table 1): Globose to subglobose, beehive shaped, with medium high spire, solid to thick; periphery markedly angulated, upper sector of whorls rather flat, basal sector rounded; umbilicus open, 70–90% concealed; lightly brown, subsutural and peripheral bands absent or diffuse, thin, brown, visible on last whorl(s) only, outer lip dark chestnut brown, inner lip blending from dark brownish pink outside to horn deeper inside. Protoconch 2.8 mm in diameter, comprising about 1.2 whorls, rather smooth. Teleoconch smooth except faint growth lines. Angle of aperture 45°; outer lip rounded, thick, slightly to well expanded, slightly reflected, basal node of lip weak, palatal node absent.

Genital anatomy (Figs. 22–23): Penis about as long as anterior part of oviduct, straight, bulbous penis proper restricted to proximal 2/3 of penial complex; vas deferens forming simple loop before entering penis; penial retractor muscle equivalent to about 2/3 of penial length; penial sheath thick; verge large (~ 1/4 penial chamber), elongate; penial wall densely covered with minute pustules, predominantly smooth, a few, irregularly arranged pustules forming at mid-portion; main stimulatory pilaster broadly cone-shaped, consisting of broad lateral ridges, comprising central portion of penial chamber. Vas deferens entering penial sheath apically, reflexing within sheath before entering penis proper. Vagina short, distally inflated, inner vaginal wall densely covered with minute pustules, predominantly smooth with few, indistinct longitudinal pilasters. Bursa

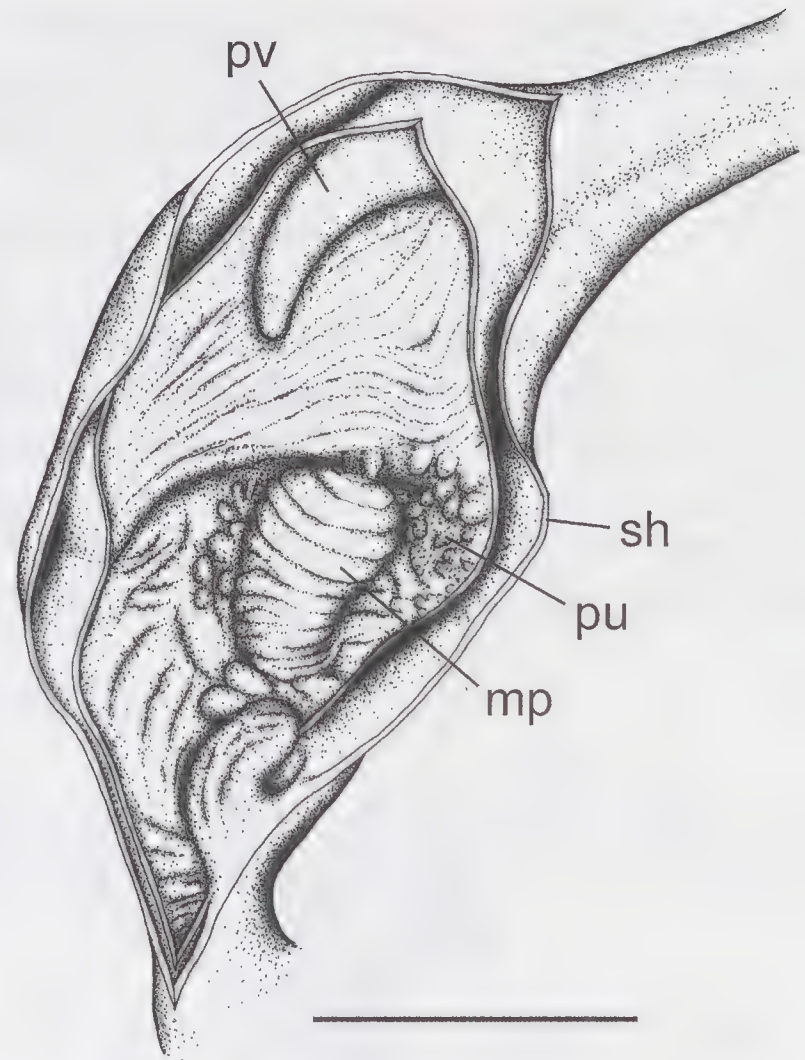


FIG. 23. Penial anatomy of *Amplirhagada globosa* n. sp. paratype AM C471713 (St Patrick Island; February). Scale bar = 2 mm.

copulatrix moderately wide; with inflated head, connected with oviduct by connective tissue.

Comparative Remarks

Anatomical description based on dissection of three specimens. Most similar with *A. sphaeroidea* from St. Andrews Island, *A. camdenensis* from Augustus Island and *A. uwinsensis* from Uwins Island. Differing from *A. sphaeroidea* by proportionally higher shell (smaller diameter, same height), from *A. camdenensis* by proportionally higher shell (same diameter, lower height). Most distinct sculpture of inner penial wall with *A. globosa* lacking obliquely lateral lamellae and main pilaster tapering anteriorly as in *A. sphaeroidea* but having a well-differentiated main stimulatory pilaster, which is lacking in *A. camdenensis*. *Amplirhagada uwinsensis* has a similar shell, but more vividly coloured, purplish-brown aperture and completely concealed umbilicus; also differing from *A. globosa* by very strongly sculptured inner penial wall with huge main stimulatory pilaster and two accessory pilasters.

Distribution (Fig. 3)

St. Patrick Island.

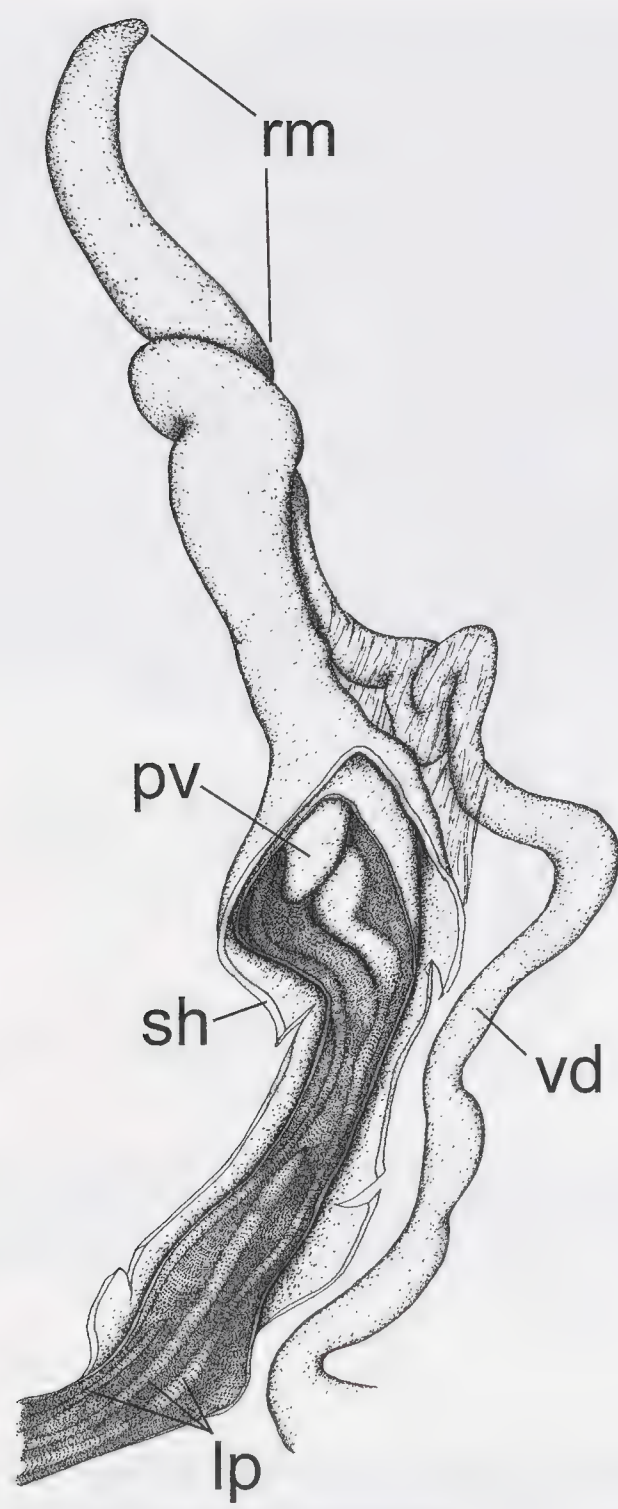


FIG. 24. Penial anatomy of *Amplirhagada basilica* (paratype AM C463720, Augustus Island; June). Scale bar = 3 mm.

Amplirhagada basilica Köhler, 2010
Figs. 4Q, 24

Amplirhagada basilica Köhler, 2010a: 264–266,
figs. 73–75.

Type Locality

Western Australia, central Kimberley coast, Bonaparte Archipelago, Brecknock Harbour, southern section of Augustus Island, 15°23'53"S, 124°036'03"E.

Material Examined

Holotype WAM S34623 (Fig. 4Q). Paratypes AM C463720 (4 preserved specimens), WAM S37004 (11 preserved specimens) from type locality; AM C463721 (3 shells), WAM S37414 (4 shells) from 15°22'54"S, 124°35'24"E.

Additional, non-type material WAM S37000–3, WAM S37413, WAM S49002, WAM S49004 from southern section of Augustus Island.

Diagnosis

Shell: Subglobose, broadly beehive shaped, with medium high spire, periphery slightly angulated, upper and basal sectors of whorls rounded, umbilicus 80–95% concealed; colour blending from crème into brownish (upper sector of lower whorls darker), subsutural band diffuse, light brownish, peripheral band diffuse, brownish, visible on last whorls only, outer lip brownish purple, inner lip pinkish. Teleoconch smooth except indistinct growth lines (Fig. 4Q, Table 1).

Genital anatomy: Penial verge comprising 1/8–1/4 of penial chamber; penial wall smooth, main stimulatory pilaster absent, two smooth, narrow longitudinal pilasters form along entire length of penial chamber, two additional smooth, narrow pilasters form at anterior base (Fig. 24). Vas deferens entering penial sheath apically.

Comparative Remarks

One of the species with dome- to beehive-shaped shells; being among the largest species of the genus; differing from *A. tricenaria* and *A. regia* by dark outer lip. Purplish colour of outer lip similar to *A. sphaeroidea*. Absence of penial wall pustules is diagnostic.

Distribution (Fig. 3)

Augustus Island, in sympatry with *A. camdenensis* Köhler, 2010, in the northwestern part of the island.

Amplirhagada camdenensis Köhler, 2010
Figs. 4R, 25

Amplirhagada camdenensis Köhler, 2010a: 266–268, figs. 76–78.

Type Locality

Western Australia, central Kimberley coast, Bonaparte Archipelago, Camden Sound, northwestern section of Augustus Island, 15°20'16"S, 124°31'16"E.

Material Examined

Holotype WAM S34624 (Fig. 4R). AM C463722 (3 preserved specimens), WAM

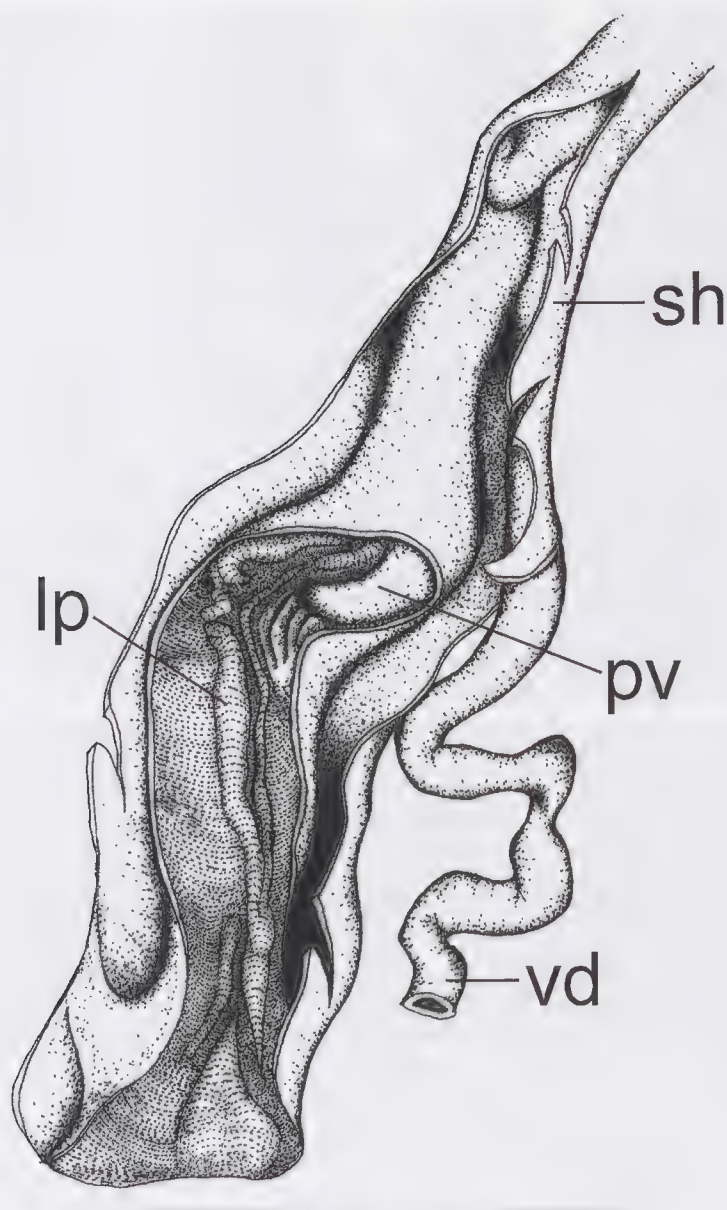


FIG. 25. Penial anatomy of *Ampilirhagada camdenensis* (paratype AM C463722, Augustus Island; May). Scale bar = 3 mm.

to median portion of penial chamber; one to three additional, smooth, narrow pilasters form distally (Fig. 25).

Comparative Remarks

Identified by Solem as "*Ampilirhagada* sp. 65"; smallest of all species with dome- to beehive-shaped shell, with significantly larger H/D ratio than most other species (Table 1). Absence of penial wall pustules and smooth, longitudinal pilasters of inner penial wall are diagnostic.

Distribution (Fig. 3)

Northwestern part of Augustus Island, in sympatry with *A. basilica*; not found in the southern part of the island.

Ampilirhagada sinenomine n. sp. Figs. 4S–T, 26–28

Type Locality

Western Australia, southwestern Kimberley, Buccaneer Archipelago, unnamed island in Doubtful Bay; 15°54'52.7"S, 124°27'47.8"E; coll. Vince Kessner, 26/05/2009, KIS 3–155 (dense patches of vine thicket at the base of sandstone outcrops; under piles of rocks).

Material Examined

Holotype WAM S37710 (preserved specimen, dissected). Paratypes WAM S37709 (4 preserved specimens), WAM S58433 (2 preserved specimens), WAM S58434 (2 preserved specimens); WAM S37711 (shell); AM C471715 (3 shells), AM C471716 (3 shells), WAM S37802 (5 shells), WAM S37803 (2 shells), WAM S37804 (2 shells), WAM S37805 (7 shells), WAM S37806 (5 shells), WAM S37807 (7 shells) from unnamed Island in Doubtful Bay.

Etymology

From "*sine nomine*" (Latin = without a name) referring to the type locality, an unnamed island in Doubtful Bay; noun in apposition.

Description

Shell (Figs. 4S–T, 26A–D; Table 1): Broadly conical to subglobose with rather high spire; periphery well rounded to slightly depressed, upper and basal sector of whorls convex; um-

S37006 (5 preserved specimens) from type locality; WAM S37005 (3 preserved specimens) from 15°20'59"S, 124°31'30"E. Additional, non-type material WAM S37007–8, WAM S37445–50, WAM S41481, FMNH 219063 from NW Augustus Island.

Diagnosis

Shell: Globose, with medium to high spire, solid, periphery evenly rounded to slightly angulated, upper sector of whorl flattened to slightly shouldered, basal sector rounded, umbilicus 40–100% concealed; yellowish brown to horn, subsutural and peripheral bands diffuse, dark to chestnut brown, becoming more indistinct or blurring towards tip of whorl, bands may blend into each other covering shell in light brown colour, whitish creme to yellowish brown ventrally, outer and inner lip colour pinkish brown. Teleoconch smooth except faint axial growth lines (Fig. 4R, Table 1).

Genital anatomy: Penial verge rather short (1/8–1/4 of length of penial chamber), broad; inner penial wall smooth; main stimulatory pilaster inconspicuous, narrow, smooth, on apical

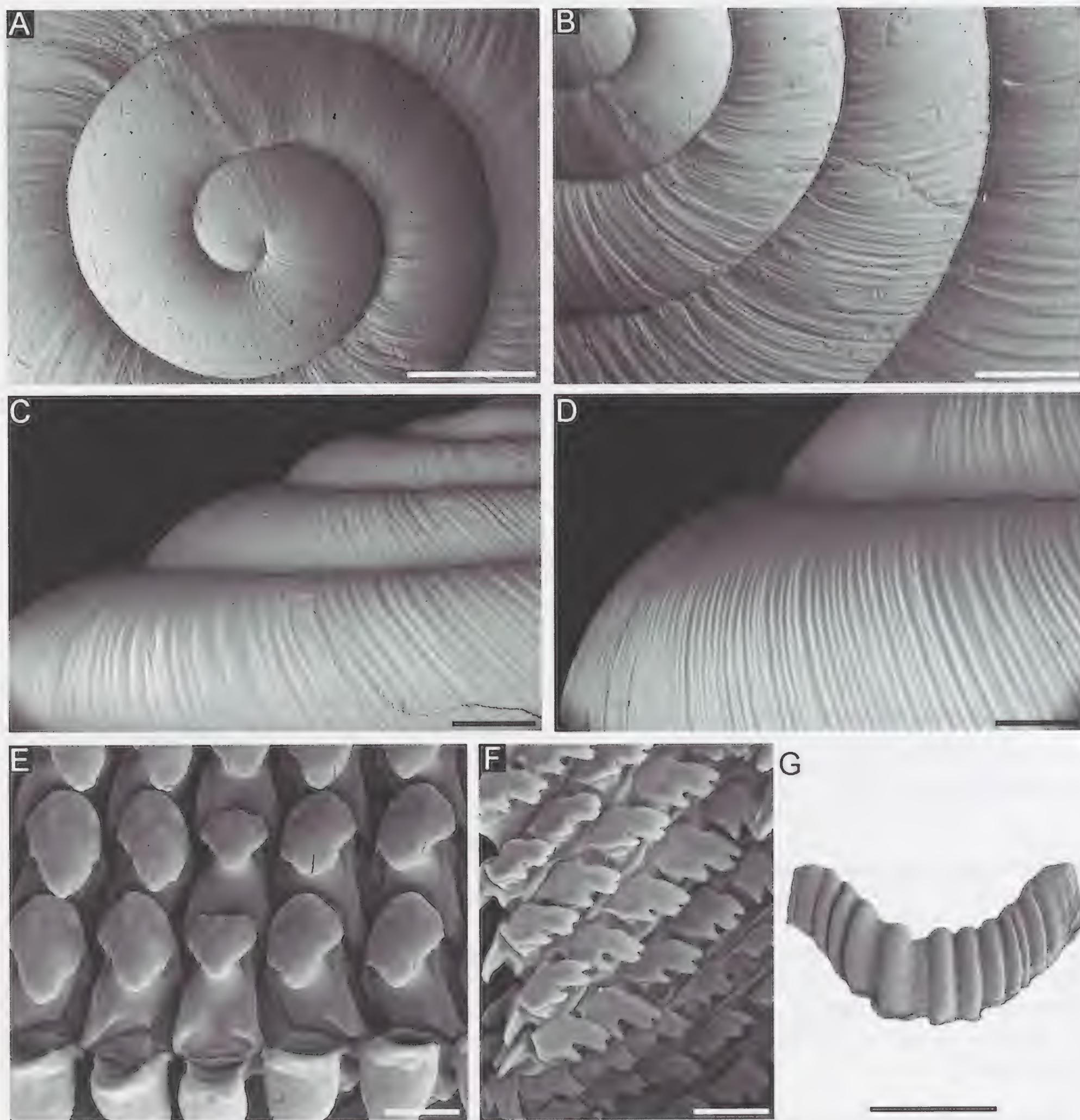


FIG. 26. SEM micrographs of *Amplirhagada sinenomine* n. sp. paratype WAM S37709 (unnamed island, Doubtful Bay). A–D: Shell. Scale bars = 1 mm. A: Apical view showing protoconch; B: Apical view showing sculpture on first four whorls; C: Front view showing sculpture on first four whorls; D: nt view showing sculpture on last whorl; E–F: Radula. Scale bars = 20 μ m; E: Central and inner lateral teeth viewed obliquely from above; F: Marginal teeth viewed obliquely from above; G: Jaw. Scale bar = 0.5 mm.

bilicus entirely concealed; background colour brownish horn, peripheral and subsutural band usually well developed, comparatively broad, dark brown, bands may blend into each other covering entire shell surface in dark brown; surface glossy; outer and inner lip colour whitish. Protoconch 2.75 mm in diameter, comprising one whorl, smooth with delicate radial wrinkles;

teleoconch smooth with faint growth lines. Angle of aperture 30 to 45°; outer lip well rounded, slightly thickened, slightly to well expanded, basal node rather small but present.

Digestive anatomy (Fig. 26E–G): Jaw consisting of 12 plates. Radula ~ 3 mm long with 126 rows of teeth ($n = 1$); C + 14–16 + 3–4 + 18–20.

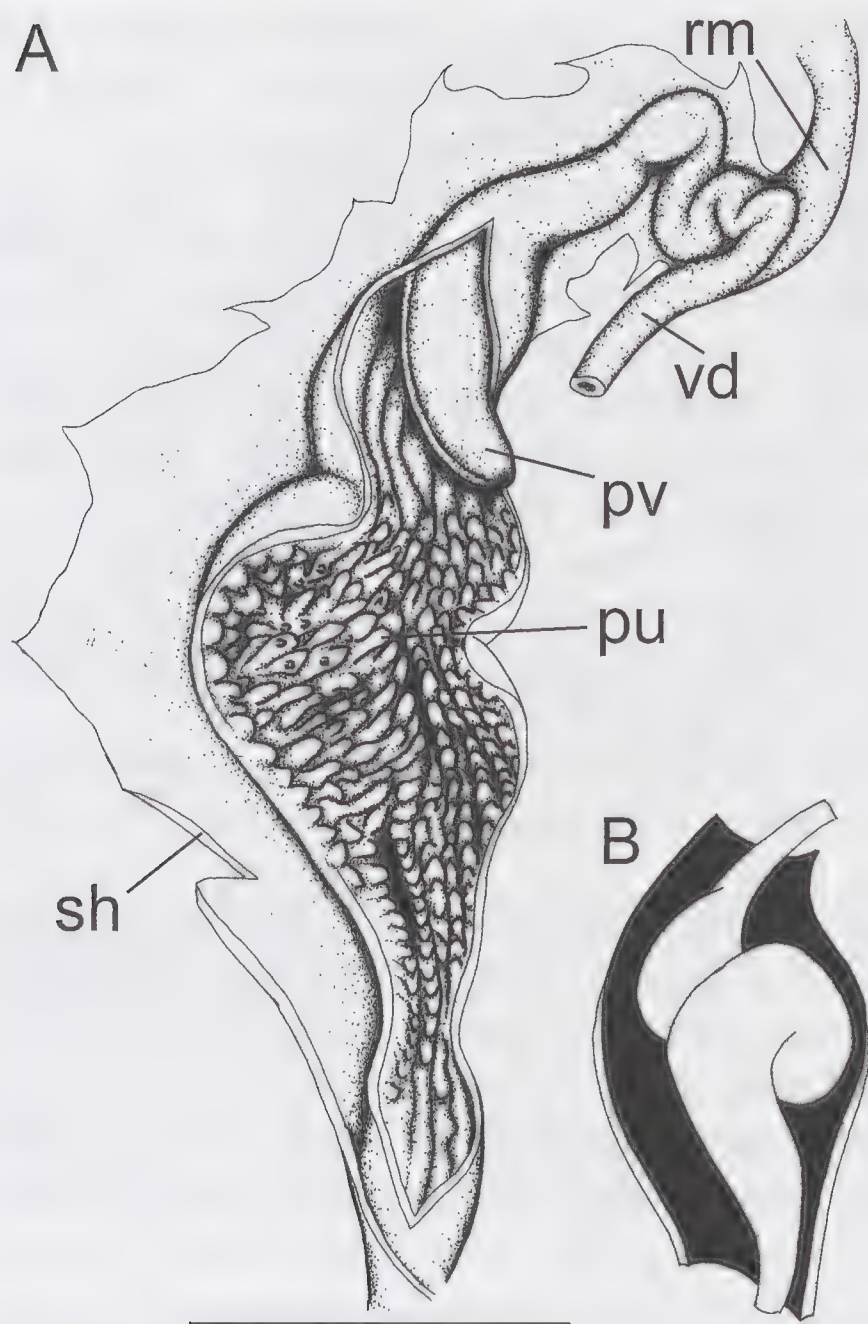


FIG. 27. Genital anatomy of *Amplirhagada sinenomine* n. sp. holotype WAM S37710 (unnamed island, Doubtful Bay; May). A: Internal anatomy of penis. Scale bar = 10 mm; B: Schematic representation of coiling of penis within penial sheath.

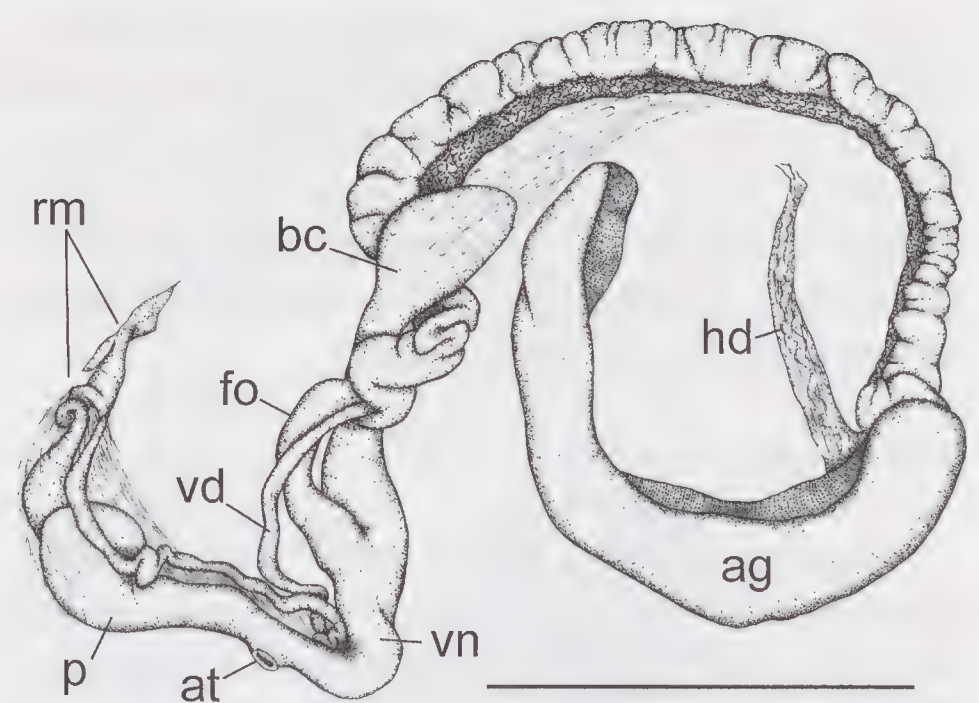


FIG. 28. Genital anatomy of *Amplirhagada sinenomine* n. sp. holotype WAM S37710 (named island, Doubtful Bay; May). Scale bar = 3 mm.

Comparative Remarks

Description based on dissection of one preserved specimen. Differing from *A. dubitabile* Köhler, 2010, from Steep Island, Doubtful Bay, by highly spired and nearly subglobose shell and lack of stimulatory main pilaster. Differing from other species with large, subglobose shells, such as *A. sphaeroidea*, *A. camdenensis*, *A. globosa* and *A. storriana* by presence of colour bands, whitish colour of apertural lip, completely concealed umbilicus, and typical pustulation of inner penial wall.

Distribution (Fig. 3)

Unnamed island in Doubtful Bay.

Amplirhagada storriana n. sp. Figs. 29–31, 37A

Type Locality

Western Australia, Southwest Kimberley, Doubtful Bay, SE section of Storr Island; 15°56'54"S, 124°33'38"E; coll. Vince Kessner, 22/05/2009, KIS 3–143 (vine thicket on W-facing steep slopes, in sandstone scree).

Material Examined

Holotype WAM S58436 (preserved specimen; Fig. 37A). Paratypes AM C471721 (4 preserved specimens), WAM S37703 (4 preserved specimens), WAM S37704 (2 preserved specimens), WAM S37705 (10 preserved specimens), WAM S37706 (3 preserved speci-

Genital anatomy (Figs. 27–28): Penis about as long as anterior part of oviduct, coiled within delicate penial sheath, vas deferens entering sheath apically; penial retractor muscle stubby; penial verge large (~ 1/5 length of penial chamber), conical, thick; penial wall entirely covered by dense pustulation, pustules comparatively large, arranged in longitudinal rows, pilasters forming at very distal and proximal end of penial wall, consisting of fused pustules; main pilaster not differentiated except that some pustules are slightly enlarged and support tiny hooks. Vagina short, distally inflated, inner vaginal wall with few, indistinct longitudinal pilasters.

Mitochondrial Differentiation

Intraspecific distance (2 sequences): 0.016; interspecific distances with respect to *A. gemina* Köhler, 2010 from near Prior Point, mainland coast about 30–40 km further north (1 sequence): 0.065–0.072, with respect to all other congeneric species (54 sequences): 0.164–0.248.

mens), WAM S37707 (3 preserved specimens), WAM S37708 (12 preserved specimens), AM C471722 (10 shells), WAM S37714 (5 shells), WAM S37715 (10 shells), WAM S37716 (21 shells), WAM S37717 (12 shells), WAM S37718 (10 shells), WAM S37819 (7 shells) from south-eastern section of Storr Island.

Etymology

In honour of Glen Milton Storr (1921–1990), Curator of Ornithology and Herpetology at the Western Australian Museum, name patron of Storr Island; adjective of feminine gender.

Description

Shell (Figs. 29A, B, 37A; Table 1): Sub-globose with medium to high spire; solid; periphery angulated; upper sector convexly rounded, slightly shouldered underneath suture, basal sectors of rounded; umbilicus 80–90% concealed. Background colour yellowish brown; subsutural

band absent or diffuse, brown; peripheral band varying in thickness and contrast, usually diffuse, brown, visible on last whorl(s) only; bands usually blending into each other across whorl surface; ventral colour whitish or identical with background; inner and outer lip colour blending into dark purplish brown. Protoconch ~ 2.9 mm in diameter, comprising about one whorl, essentially smooth with faint axial lirae. Teleoconch with fine, indistinct axial growth lines, becoming oblique towards base of shell. Angle of aperture 30–45°; outer lip rounded, slightly expanded, not or weakly reflected, basal node of lip weak, palatal node absent.

Radula (Fig. 29 C–D): 3.8 x 1.3 mm in size, with about 130 rows of teeth ($n = 1$); C + 12–13 + 4 + 18–19.

Genital anatomy (Figs. 30–31): Penis rather straight, slightly longer than anterior part of oviduct, thin, penis proper comprising proximal third only. Vas deferens relatively thick, forming elongated loop before entering penis, uncoiled. Penial retractor muscle very short. Penial

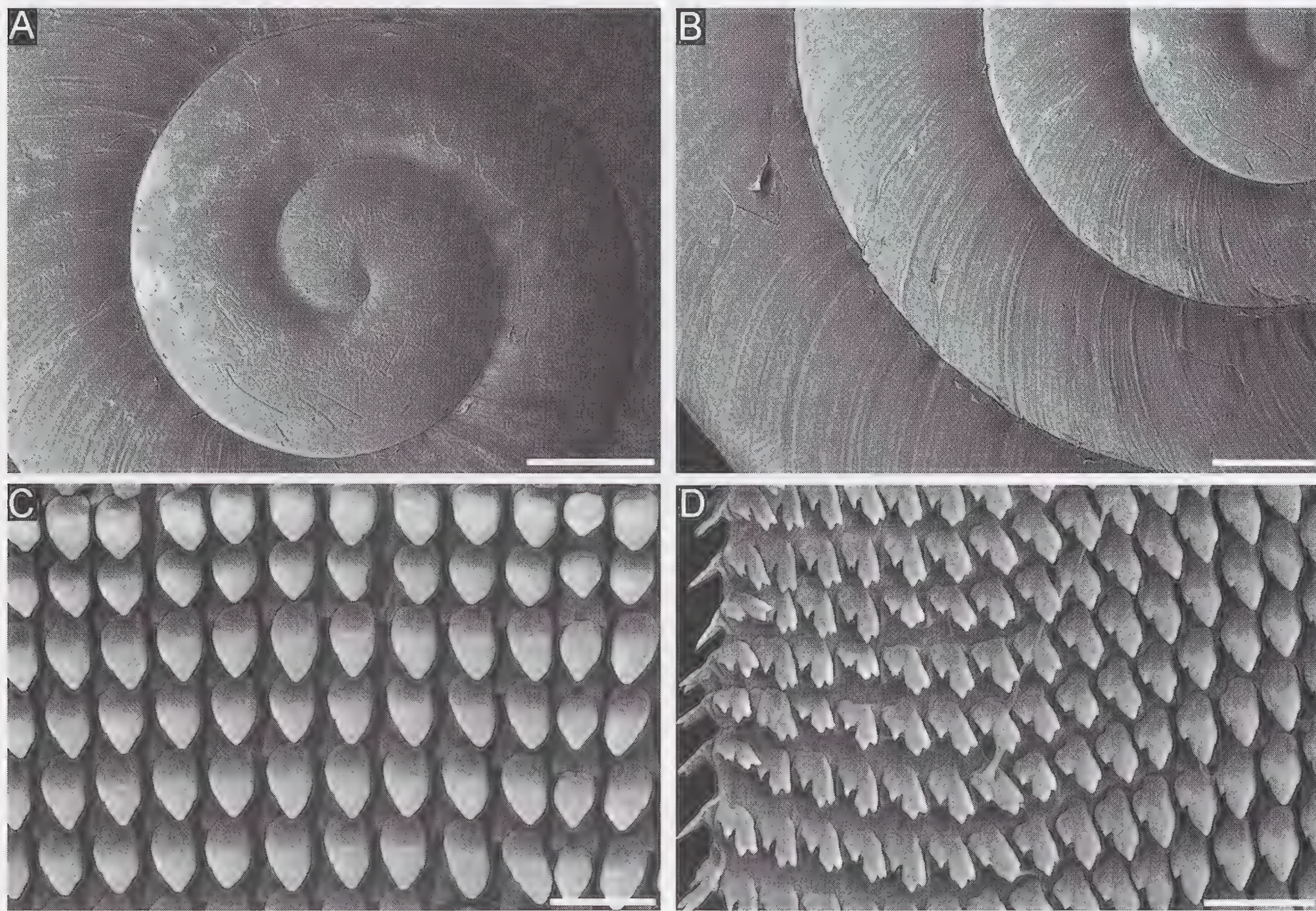


FIG. 29. SEM micrographs of *Amplirhagada storriana* n. sp. (Storr Island). A–B: Shell, paratype WAM S37703. Scale bars = 1 mm. A: Apical view showing protoconch; B: Apical view showing sculpture on first four whorls; C–D: Radula, paratype WAM S37708. Scale bars = 50 μ m. C: Central and inner lateral teeth viewed from above; D: Middle marginal and outer lateral teeth viewed from above.

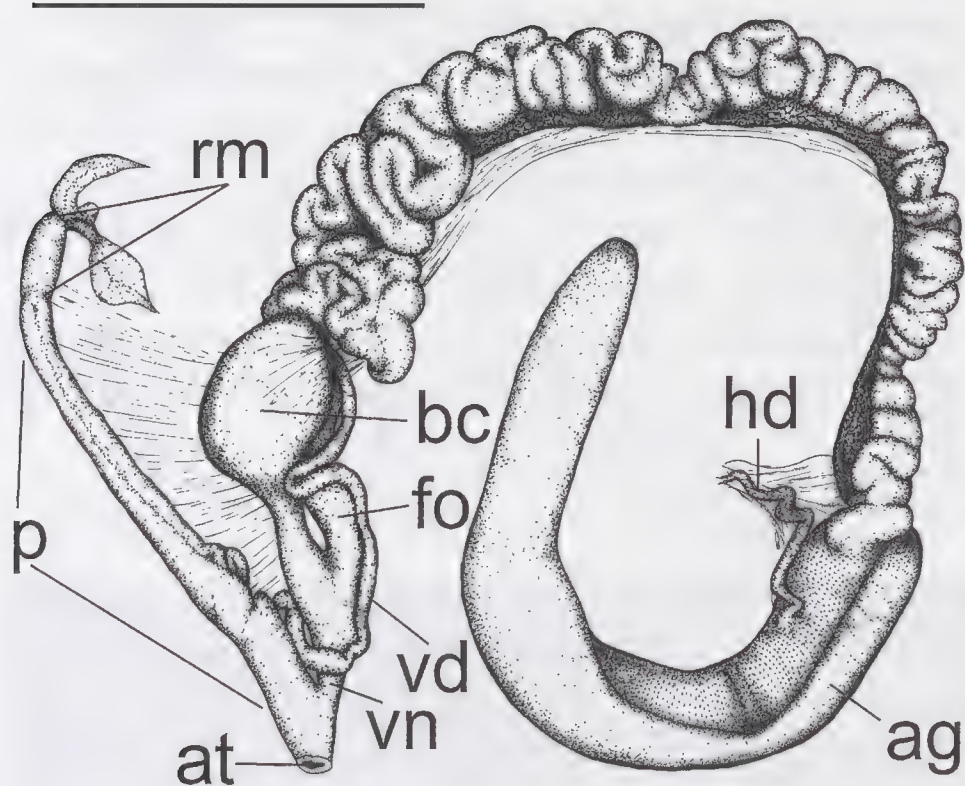


FIG. 30. Genital anatomy of *Amplirhagada storriana* n. sp. paratype AM C471721 (Storr Island; May). Scale bar = 10 mm.

verge short, slender, with pointed tip. Penial wall without pustulation; no main stimulatory pilaster differentiated; four narrow longitudinal pilasters form along entire length of inner penial wall. Vas deferens entering penial sheath at distal third.

Aestivation Strategy

Free sealer, under rocks.

Mitochondrial Differentiation

Intraspecific distance (2 sequences): 0.016; interspecific distances with respect to *A. sphaeroidea* (2 sequences): 0.102–0.107, to *A. regia* (2 sequences): 0.117–0.121, to *A. camdenensis* (1 sequence): 0.107–0.114, to *A. basilica* (1 sequence): 0.134–0.138, all other congeneric species (49 sequences): 0.184–0.254.

Comparative Remarks

One of the species with dome-shaped shells; shell most similar to *A. uwinsensis*; proportionally taller than most other species ($H/D = 0.87$), including *A. uwinsensis* (0.72), *A. sphaeroidea* (0.68), *A. regia* (0.71), *A. basilica* (0.68) and *A. globosa* (0.68). A similar size ratio in *A. camdenensis* (0.85) and *A. decora* (0.89), while *A. boongareensis* is even taller (0.97) (Table 1). *Amplirhagada camdenensis* is smaller in overall size with a comparatively higher body whorl while *A. decora* differs in banding of shell, lighter background and whitish outer lip; *A. tricenaria* and *A. regia* differ by dark brown outer

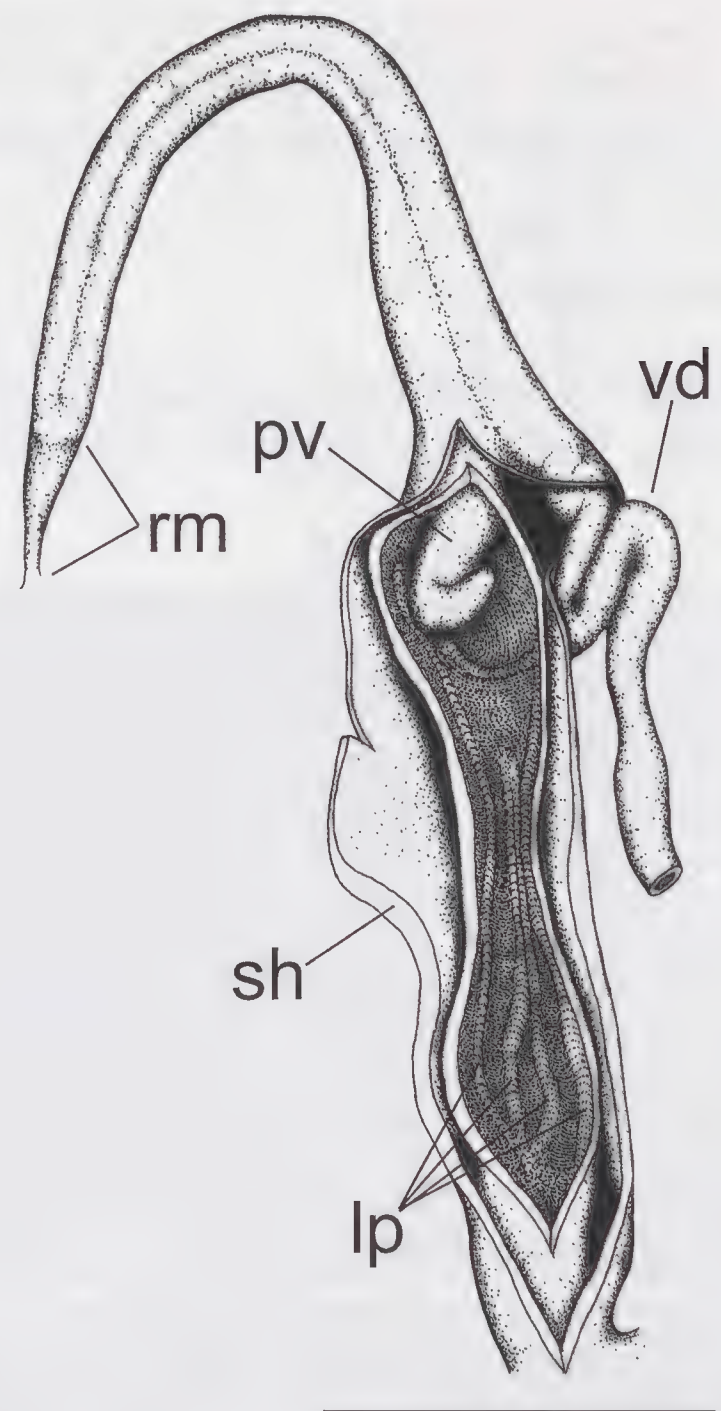


FIG. 31. Penial anatomy of *Amplirhagada storriana* n. sp. paratype AM C471721 (Storr Island; May). Scale bar = 3 mm.

lip. Penial anatomy of *A. storriana* resembles most closely that of *A. basilica* and, to a lesser degree, of *A. camdenensis* but differing in details of development of longitudinal pilasters. *Amplirhagada uwinsensis* differs most conspicuously by presence of large main stimulatory pilaster, *A. sphaeroidea* by presence of oblique lateral lamellae, *A. regia* by shorter and fewer longitudinal pilasters, *A. boongareensis* and *A. tricenaria* by presence of pustulation and main stimulatory pilaster.

Distribution (Fig. 3)

Storr Island.

Amplirhagada alkuonides n. sp. Figs. 32–34, 37B

Type Locality

Western Australia, SW Kimberley, Buccaneer Archipelago, Collier Bay, Woods Islands, King-

fisher Island; 16°05'21.8"S, 124°05'34.3"E; coll. Vince Kessner, 5/0602009, KIS 3–173 (vine thicket behind mangrooves on rocky substratum, common).

Material Examined

Holotype WAM S58435 (preserved specimen; Fig. 37B). Paratypes AM C471718 (20 pre-

served specimens), WAM S37717 (50 preserved specimens), WAM S37718 (37 preserved specimens), AM C471719 (38 shells), WAM S37828 (100 shells) from Kingfisher Island.

Additional, non-type material AM C471720 (preserved specimens), WAM S37712–6, WAM S49247–8 (preserved specimens), WAM S37825, WAM S37827 (shells) from Kingfisher Island.

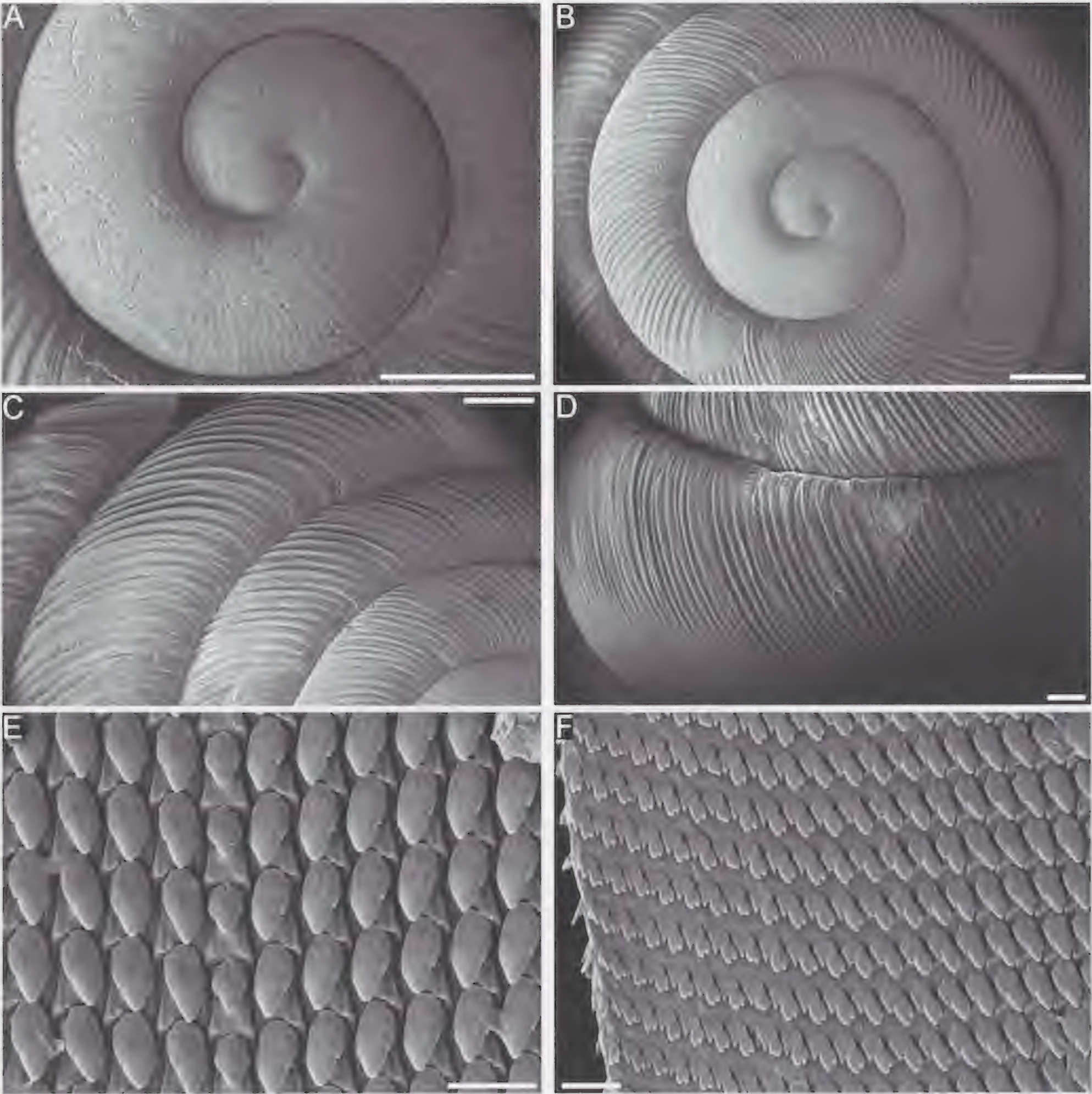


FIG. 32. SEM micrographs of *Amplirhagada alkuonides* n. sp. paratype AM C471718 (Kingfisher Island). A–D: Shell. Scale bars = 1 mm. A: Apical view showing close-up of protoconch; B: Apical view showing first whorls; C: Apical view showing sculpture on last whorls; D: Lateral view showing sculpture on body whorl; E–F: Radula. Scale bars = 50 µm. E: Central and inner lateral teeth viewed from above; F: Middle marginal and outer lateral teeth viewed from above.

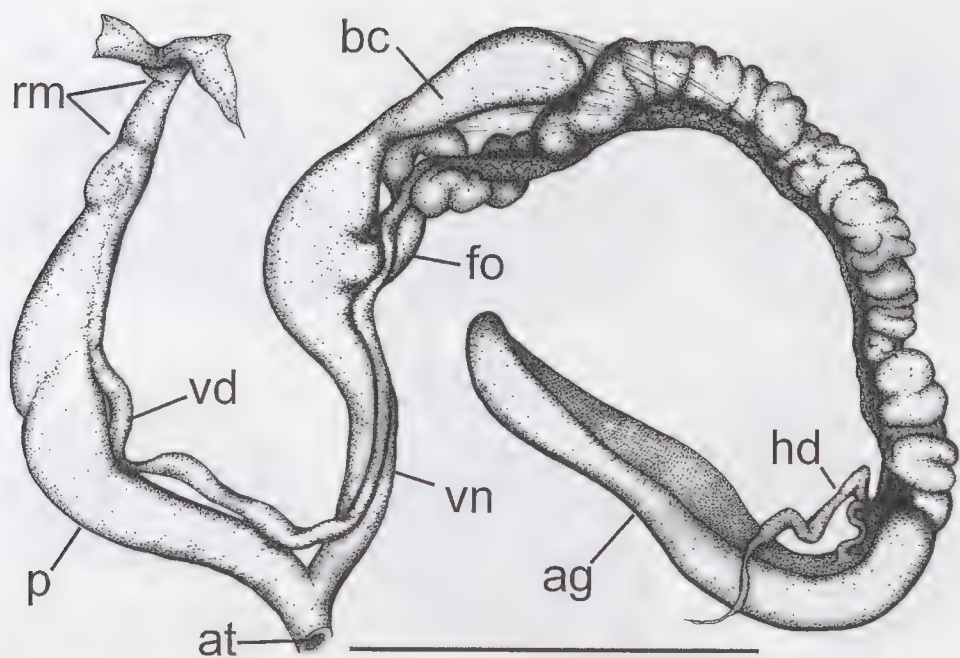


FIG. 33. Genital anatomy of *Amplirhagada alkuonides* n. sp. paratype AM C471718 (Kingfisher Island; June). Scale bar = 10 mm.

Etymology

Derived from the Greek word ἄλκυών (alkuōn = kingfisher). The feminine suffix “-ides” comes from εἶδος (eidos), meaning “type” or “kind”; referring to the name of Kingfisher Island; adjective of feminine gender.

Description

Shell (Figs. 32A–D, 37B; Table 1): Broadly conical with low spire; thin (translucent) but solid; periphery well rounded to slightly angulated, upper and basal sectors of whorls rounded; umbilicus 50–90% concealed. Background and ventral colour whitish crème to horn; peripheral and subsutural bands well marked, brown, visible on basal whorls; outer and inner lip colour white. Protoconch 2.9 mm in diameter, comprising about one whorl, sculptured by very indistinct axial pustulation. Teleoconch with well developed, regularly spaced axial ribs, evenly distributed across entire surface of shell, reduced in prominence below suture. Angle of aperture ~ 45°; outer lip moderately thick, well rounded, expanded, not or weakly reflected; basal node weak, palatal node absent.

Radula (Fig. 32E, F): 4.3 mm long, with 125 rows of teeth; C + 14–16 + 4 + 12–14 (n = 2).

Genital anatomy (Figs. 33–34): Penis long, tubular, coiled within delicate penial sheath, vas deferens entering sheath in distal third; penial wall thick, penial verge elongately conical with rounded tip, 1/10 to 1/8 of length of penial chamber; penial wall entirely covered with very fine and dense pustulation, pustules small, elongated, with rounded tip, arranged

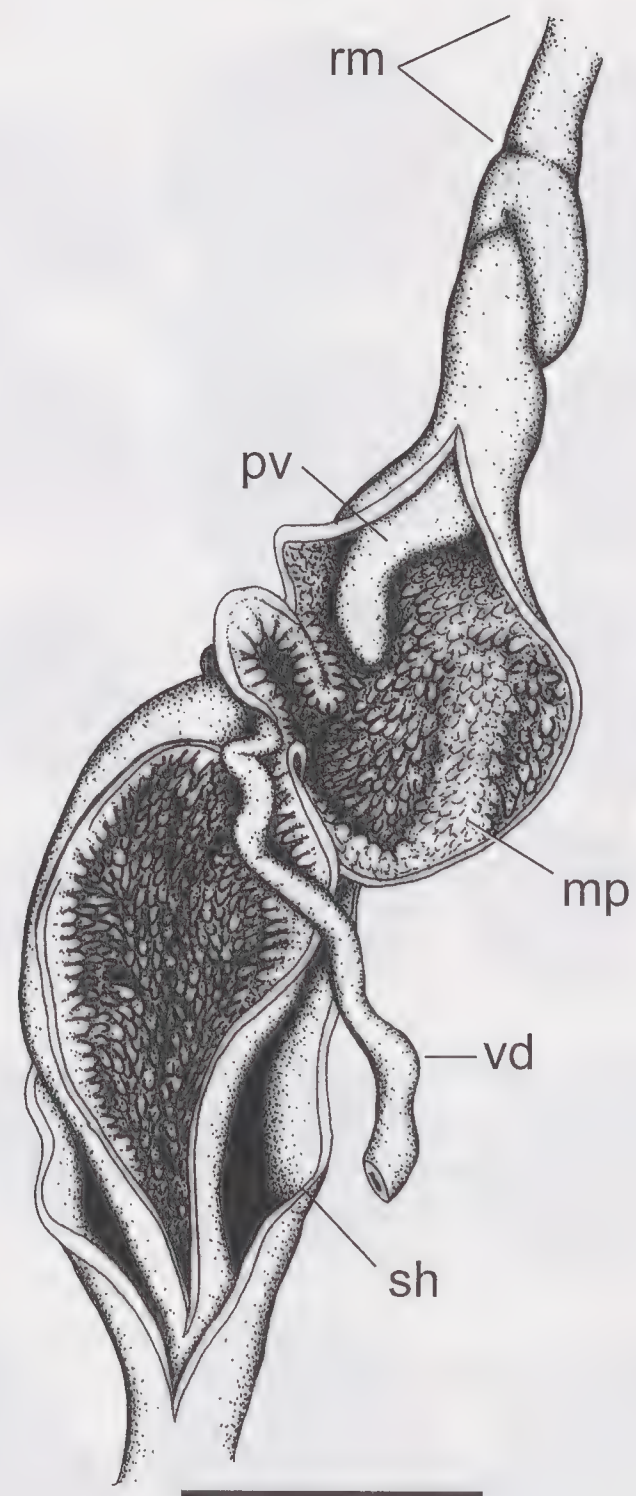


FIG. 34. Penial anatomy of *Amplirhagada alkuonides* n. sp. paratype AM C471718 (Kingfisher Island; June). Scale bar = 3 mm.

in longitudinal rows, main stimulatory pilaster weakly differentiated, comprising apical third of penial wall, densely covered by pustules. Vagina considerably elongated, tubular. Bursa copulatrix long, considerably extending base of spermoviduct; with inflated head, inner wall with many irregular, rather narrow longitudinal pilasters. Spermoviduct much longer than anterior part of oviduct.

Aestivation Strategy

Free sealer.

Mitochondrial Differentiation

Intraspecific distance (2 sequences): 0.012; interspecific distances with respect to *A. cf. astuta* from Molema Island: 0.051, to all other congeneric species (56 sequences): 0.166–0.255.

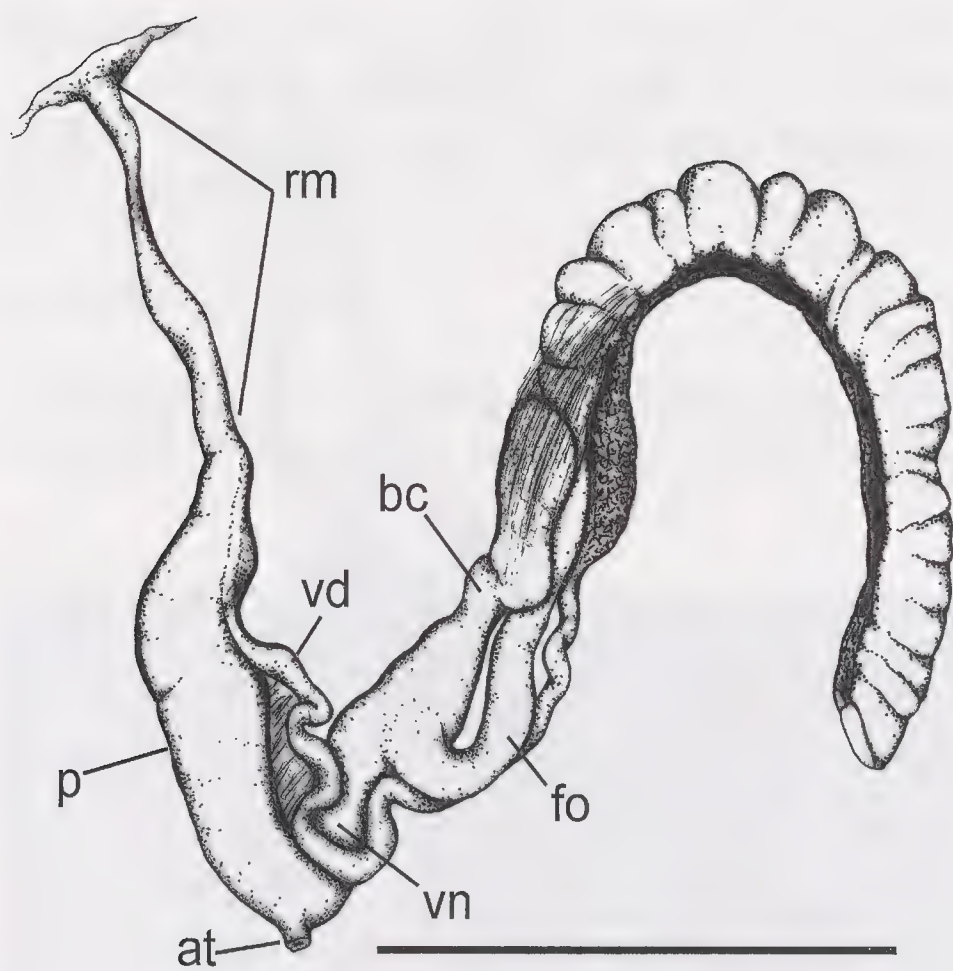


FIG. 35. Genital anatomy of *Amplirhagada* cf. *astuta* (WAM S49262, Molema Island; February). Distal part of spermoviduct with albumen gland ripped off. Scale bar = 10 mm.

Comparative Remarks

Anatomical description based on dissection of two specimens. Specimens with nearly identical shells were found on Melomys Island (Woods Island group, less than 10 km south of Kingfisher Island), considered conspecific. Specimens from mainland (Walcott Inlet, 1 km from coast, 16°21'20"S, 124°45'55"E), identified by Solem as "*Amplirhagada* NSP37" (housed in FMNH), have similar shells; their status being under investigation. Shells of *A. alkuonides* resemble none of the species from other islands in southern part of the Kimberley coast, which usually exhibit subglobose to dome-like shells. Similar to species that occur much further north, such as *A. indistincta* and *A. solemiana*. These species differ by presence of several longitudinal pilasters that form along entire inner surface of inner penial wall. The elongated bursa copulatrix, which considerably extends anterior end of spermoviduct is diagnostic.

Distribution (Fig. 3)

Woods Island group, on Kingfisher and Melomys islands.

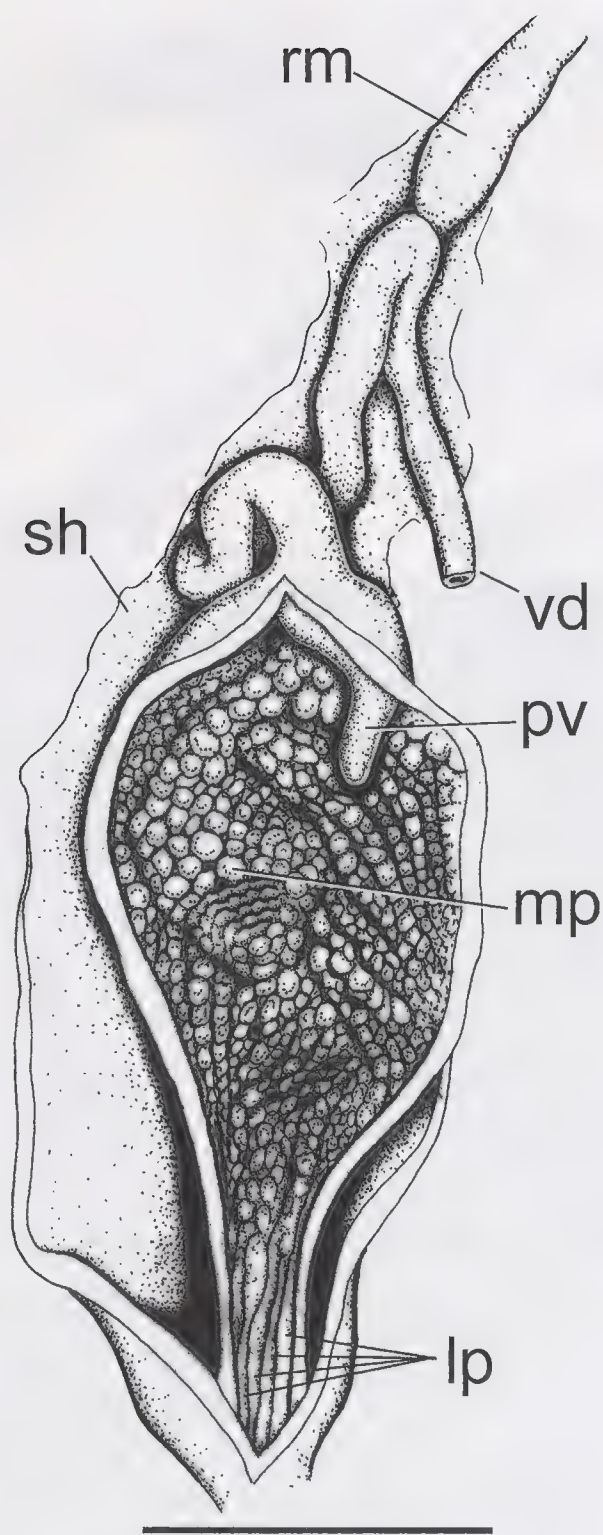


FIG. 36. Penial anatomy of *Amplirhagada* cf. *astuta* (WAM S49262, Molema Island; February). Scale bar = 3 mm.

Amplirhagada cf. *astuta* (Iredale, 1939)
Figs. 35, 36, 37C

Rhagada astuta Iredale, 1939: 63, pl. IV, fig. 17.
Amplirhagada astuta – Solem, 1981a: 208–211,
Fig. 46; McKenzie et al., 1995: 251.

Type Locality

Western Australia, southwest Kimberley, Yam-
pi Sound, Koolan Island (16°08'S, 123°45'E).

Taxonomic Remarks

The name was introduced by Iredale (1939)
based on a leached and worn shell as member
of *Rhagada*. Subsequently transferred to *Am-*

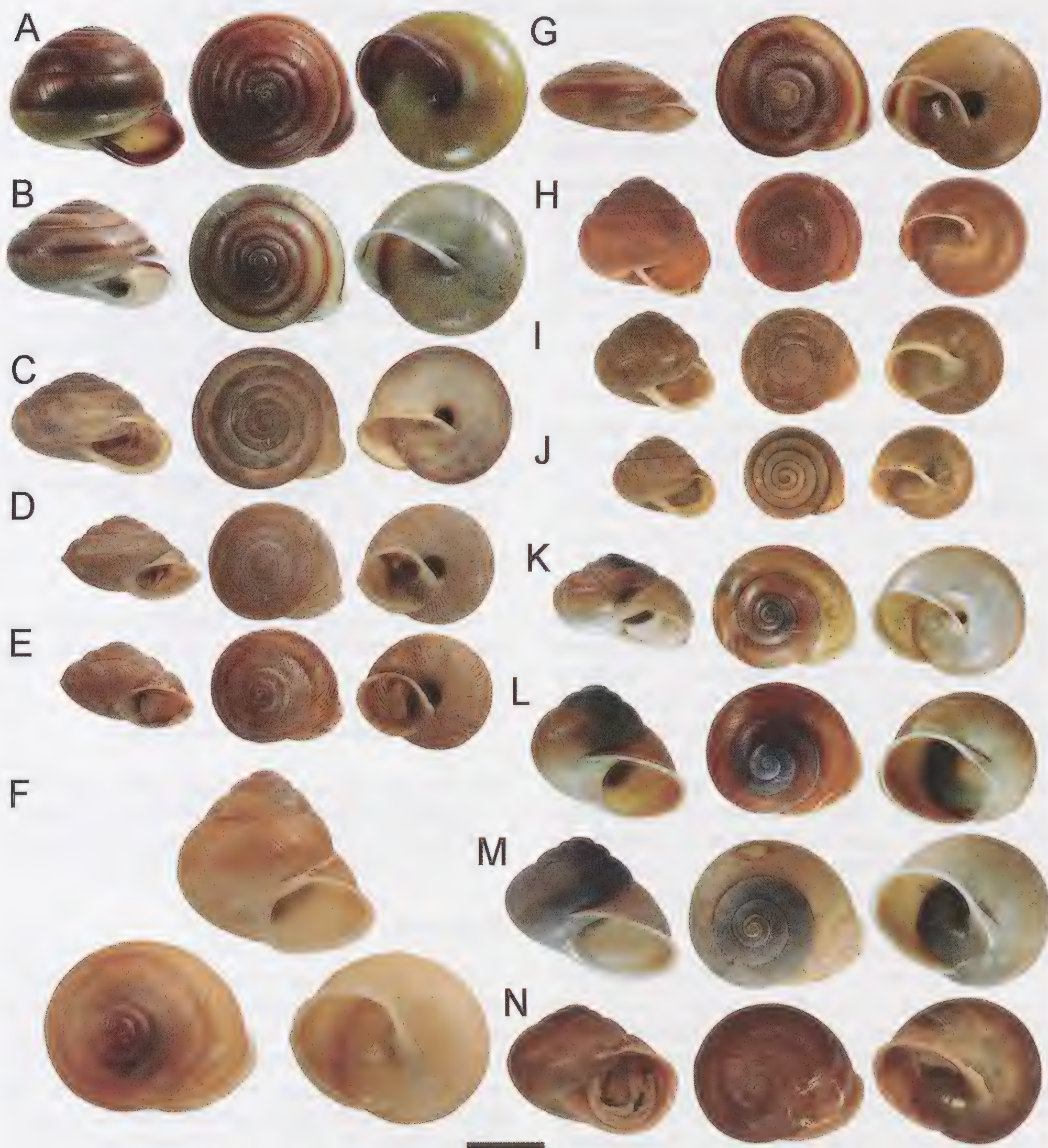


FIG. 37. Shells of *Amplirhagada* (continued), *Carinotrachia*, *Kimberleymelon*, *Kimberleydiscus*, and *Kimboraga*. A: *A. storriana* n. sp. holotype WAM S58436 (Storr Island); B: *A. alkuonides* n. sp. holotype WAM S58435 (Kingfisher Island); C: *A. astuta* WAM S37808 (Molema Island). D: *Carinotrachia admirale admirale* holotype WAM S34628 (Middle Osborn Island); E: *Carinotrachia admirale elevata* holotype WAM S34629 (Southwest Osborn Island); F: *Kimberleymelon tealei* holotype WAM S36877 (Middle Osborn Island); G: *Kimberleydiscus fasciatus* holotype WAM S34630 (Bigge Island); H: *Australocosmica augustae* holotype WAM S34667 (Augustus Island); I: *Australocosmica sanctumpatriciusae* holotype WAM S34666 (St Patrick Island); J: *Australocosmica vulcanica* holotype WAM S34668 (unnamed island, Vulcan Group); K: *Kimboraga glabra* n. sp. holotype WAM S58437 (Coronation Island); L: *Kimboraga exanima* WAM S37622 (St Andrews Island); M: *Kimboraga wulalam* n. sp. holotype WAM S58438 (Wulalam Island); N: *Kimboraga cascadiensis* n. sp. holotype WAM S58439 (Lachlan Island). Note that foot tissue protrudes from some shells. Scale bar = 10 mm.

plirhagada by Solem (1981a), who considered it a *nomen nudum* for lack of information that would permit its recognition. Later observations confirmed existence of *A. astuta* on Koolan Island (McKenzie et al., 1995). Because occurrence on Molema Island, about 20 km SW of Koolan Island, is considered likely, present material is assigned to this name and used to redescribe the taxon. A final evaluation of the status of the Molema Island samples with respect to the type material awaits comparative analyses of topotypic material.

Material Examined

WAM S49262 (preserved animal without shell), WAM C37808 (shell) from Talbot Bay, northern section of Molema Island, 16°14'17.4"S, 123°49'49.5"E.

Description

Shell (Fig. 37C; Table 1): Broadly conical with low spire; thin (translucent) but solid; periphery well rounded, upper and basal sectors of whorls rounded; 10% concealed. Background and ventral colour whitish crème to horn; peripheral and subsutural bands well marked, brown, visible on basal whorls; outer and inner lip colour white. Teleoconch with faint, regularly spaced axial growth lines, evenly distributed across entire shell surface. Angle of aperture ~ 45°; outer lip sharp, well rounded, strongly expanded, weakly reflected; basal node weak, palatal node absent.

Genital anatomy (Figs. 35–36): Penial complex elongate, with bulbous proper, not coiled within penial sheath, vas deferens entering sheath in distal third of penial complex; verge elongate to narrowly conical with rounded tip, < 1/10 of length of penial chamber; penial wall entirely covered with dense pustulation, pustules moderate in size, roundish, arranged in irregular, obliquely longitudinal rows, main stimulatory pilaster weakly differentiated, comprising distal third of penial wall, consisting of lateral, corrugated lamellae formed by fused pustules; proximal portion of inner wall with weak longitudinal pilasters. Vagina short, inflated, inner wall with weak longitudinal pilasters. Bursa copulatrix long, slightly extending base of spermoviduct; head inflated, inner wall with many irregular, rather narrow longitudinal pilasters. Spermoviduct longer than anterior part of oviduct.

Mitochondrial Differentiation

Interspecific distances with respect to *A. alkuonides* (2 sequences): 0.051, to all other congeneric species (56 sequences): 0.186–0.241.

Comparative Remarks

Shells from Molema Island exhibit corresponding features with the holotype (flat and broad shape, partly open umbilicus, expanded lip, smooth sculpture, and number of whorls). Compared to *A. alkuonides* from Kingfisher Island, ~ 25 km NE of Molema Island, *A. astuta* has a flatter, smoother shell, entirely open umbilicus, more expanded apertural lip; genital anatomy differing by larger, more rounded pustules, proportionally shorter vagina and bursa copulatrix.

Distribution (Fig. 3)

Koolan Island, Yampi Sound, and Molema Island, Talbot Bay; occurrence on adjacent mainland likely.

Carinotrachia Solem, 1985

Carinotrachia Solem, 1985a: 857–863; 1991: 214; Solem & McKenzie, 1991: 247–263; Köhler, 2010b: 2–6. Type species: *Carinotrachia carsoniana* Solem, 1985, by original designation.

Diagnosis

Shell: Medium sized (D = 15.5–18.5 mm), moderately thick, broadly conical, moderately elevated; umbilicus narrowly open; protoconch with strong radially elongated pustulation; teleoconch sculptured by strongly developed radial ribs, ribs extending onto base of shell, microscopic granulation may be present; whorls rapidly increasing, separated by deep suture; periphery keeled. Shell colour uniform, yellowish brown.

Genital anatomy: Penis with well-developed sheath, extending entire length, usually thick proximally, thin distally; inner penial wall with complex pilasters; epiphallus absent; penial retractor muscle attached to junction with vas deferens. Vas deferens entering penial sheath apically, entering penial chamber through simple pore. Bursa copulatrix simple, short (slightly extending anterior end of spermoviduct).

Radula: 3.5–5.5 mm long, with 120–140 rows of teeth, tooth formula: C + 12–14 + 3–4 + 13–15.

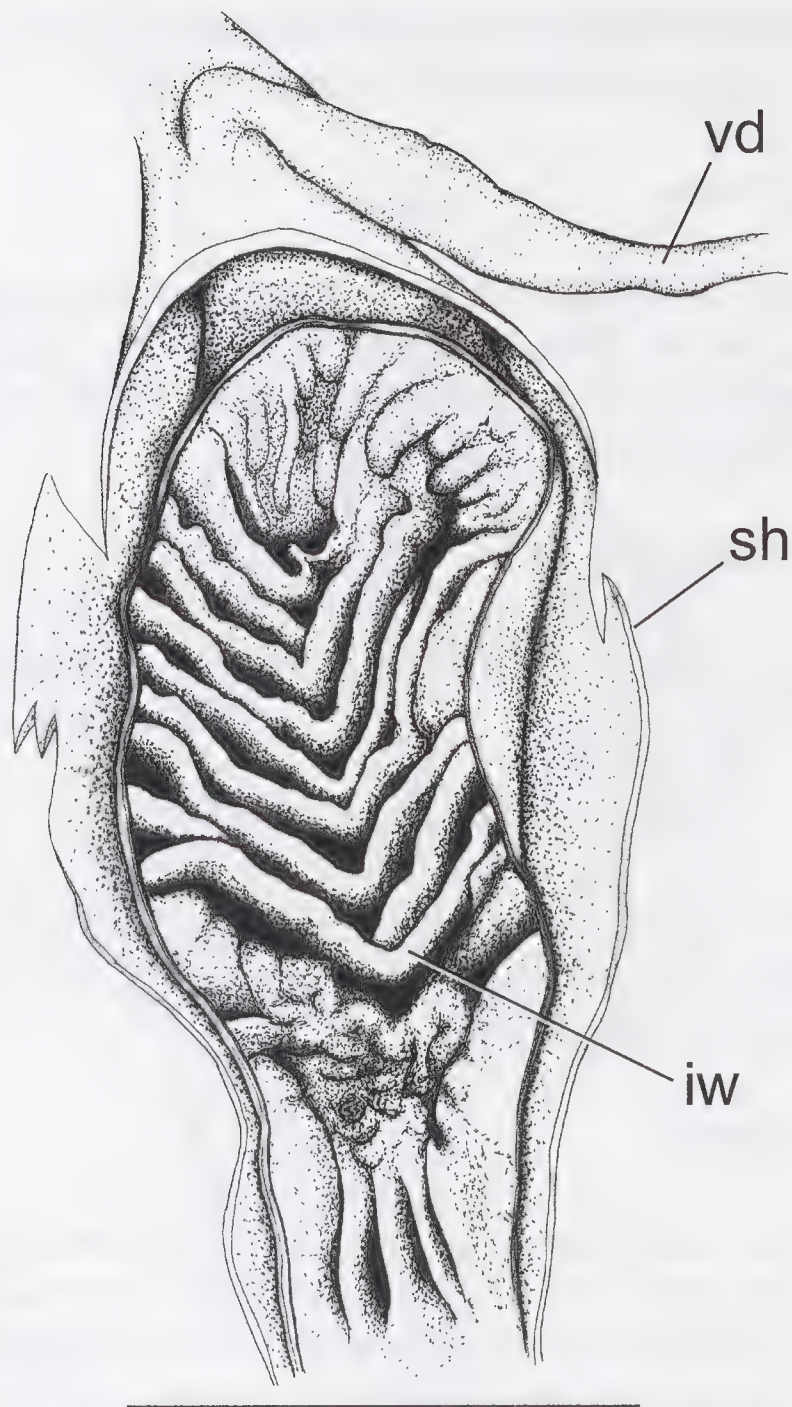


FIG. 38. Penial anatomy of *Carinotrachia admirale admirale* (AM C463606, Middle Osborn Island; May). Scale bar = 3 mm.

Aestivation Strategy

Rock sealer (Solem, 1985; Köhler, 2010b).

Diversity and Distribution

Two species are currently known: The type species, *C. carsoniana* from south of Kalumburu on the mainland and *C. admirale* with each a distinct subspecies on Middle and Southwest Osborn islands, respectively, about 60 to 80 km W of Kalumburu.

Carinotrachia admirale admirale
Köhler, 2010
Figs. 37D, 38

Carinotrachia admirale admirale Köhler, 2010b:
3–6, figs. 2A, 3–5.

Type Locality

Western Australia, northwestern Kimberley, Bonaparte Archipelago, Admiralty Gulf, E coast of Middle Osborn Island, 14°18'57.1"S, 126°01'59.6"E.

Material Examined

Holotype WAM S34628 (preserved specimen; Fig. 37D). Paratypes AM C463606 (32 preserved specimens), WAM S36600 (100 preserved specimens) from type locality.

Diagnosis

Shell: Thin, strongly depressed, with about four regularly expanding whorls, strongly keeled periphery, upper part of whorl slightly shouldered, basal part convexly flattened; umbilicus narrowly open, 20% concealed; uniform crémish brown to horn; sculptured by regularly-spaced, rounded, prosocline axial ribs, reduced in prominence below suture and within umbilicus, spaces between ribs about twice as wide as thickness of the ribs, minute periostracal nodules sparsely distributed on last one to two whorls, but dense on basal part of shell and within umbilicus; outer lip well rounded, sharp, without parietal or basal notch (Fig. 37D).

Genital anatomy: Inner penial wall covered with dense pilasters in irregular fishbone-pattern, no stimulatory main pilaster (Fig. 38).

Comparative Remarks

Similar to *C. carsoniana* Solem, 1985, with respect to shell shape, size and sculpture but differing by presence of small nodules on shell surface, which are largely absent in *C. carsoniana*, more rounded shape of ribs, comparatively larger distances between ribs, and in anatomy of inner penial wall (*C. carsoniana* with much more irregularly arranged pilasters). In *C. carsoniana* vas deferens communicates with lumen of penis through valvular ridge; in *C. admirale* through simple pore.

Distribution

Middle Osborn Island, in rainforest patches.

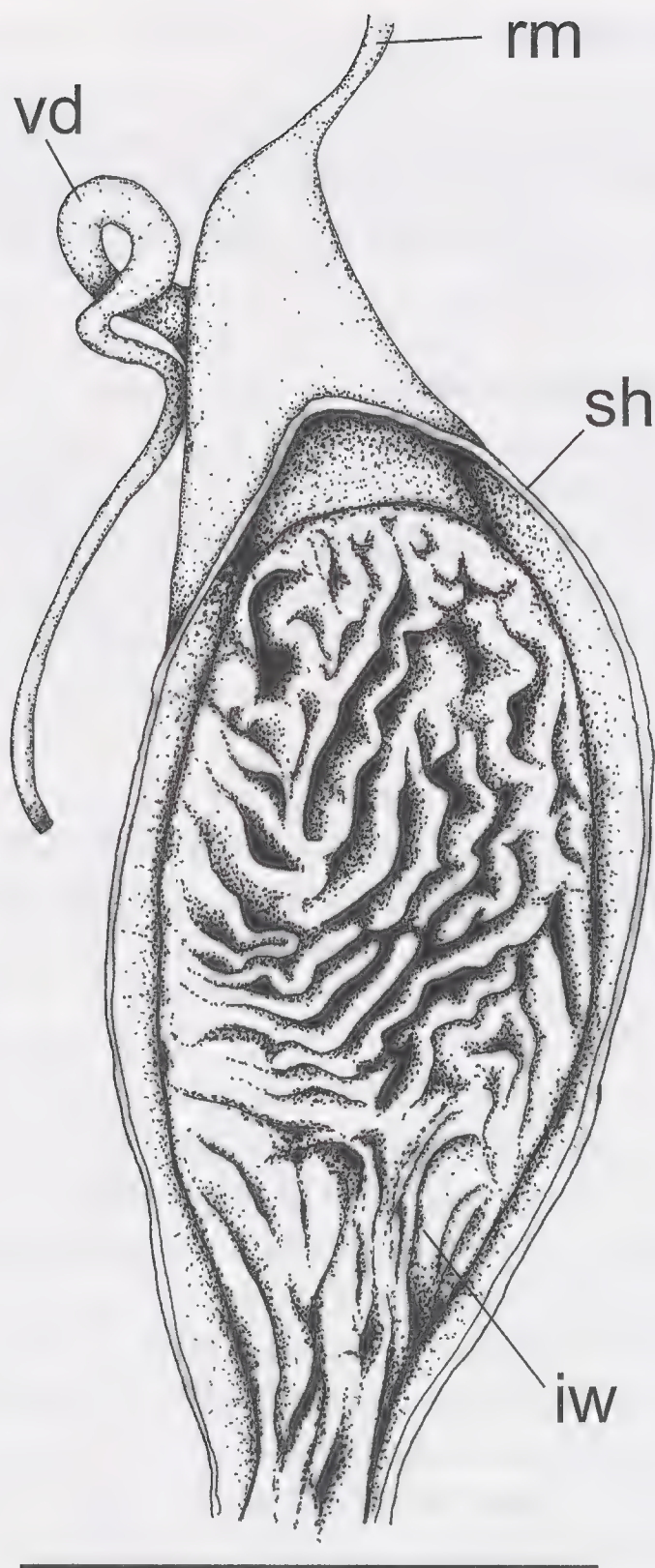


FIG. 39. Penial anatomy of *Carinotrachia admirale elevata* (AM C463607, Southwest Osborn Island; May). Scale bar = 3 mm.

Carinotrachia admirale elevata
Köhler, 2010
Figs. 37E, 39

Carinotrachia admirale elevata Köhler, 2010b:
3–6, figs. 2B, 6–8.

Type Locality

Western Australia, northwestern Kimberley, Bonaparte Archipelago, Admiralty Gulf, E coast of Southwest Osborn Island, 14°22'47.3"S, 125°56'00.6"E.

Material Examined

Holotype WAM S34629 (preserved specimen; Fig. 37E). Paratypes AM C463607 (10

preserved specimens), WAM S36857 (27 preserved specimens) from type locality.

Diagnosis

Like nominate form but with weaker spiral keel, more elevated spire (Fig. 37E), more irregularly arranged pilasters on the inner penial wall (Fig. 39).

Distribution

Southwest Osborn Island, in rainforest patches.

Kimberleymelon Köhler, 2010

Kimberleymelon Köhler, 2010b: 6–9. Type species: *Kimberleymelon tealei* Köhler, 2010, by original designation.

Diagnosis

Shell: Comparatively large, trochiform, high-spired, moderately thick; umbilicus completely concealed; protoconch rather smooth with faint radial growth lines; teleoconch with prominent radial growth lines, extending onto base of shell; whorls rapidly increasing, separated by flat suture; periphery slightly depressed.

Genital anatomy: Penis with well-developed sheath, extending entire length, thick proximally, thin distally; inner penial wall with pustulation and well-developed main pilaster; epiphallus wanting, simple, tubular reflection of vas deferens; penial retractor muscle attached to junction of epiphallus with vas deferens. Vas deferens entering penial sheath apically, epiphallus entering penial chamber through indistinct vergic papilla. Bursa copulatrix simple, short (reaching anterior end of spermoviduct).

Aestivation Strategy

Rock sealer.

Diversity and Distribution

This monotypic genus is known from Middle Osborn Island only.

Kimberleymelon tealei Köhler, 2010
Figs. 37F, 40

Kimberleymelon tealei Köhler, 2010b: 8–12, Figs. 2D, 9–11.

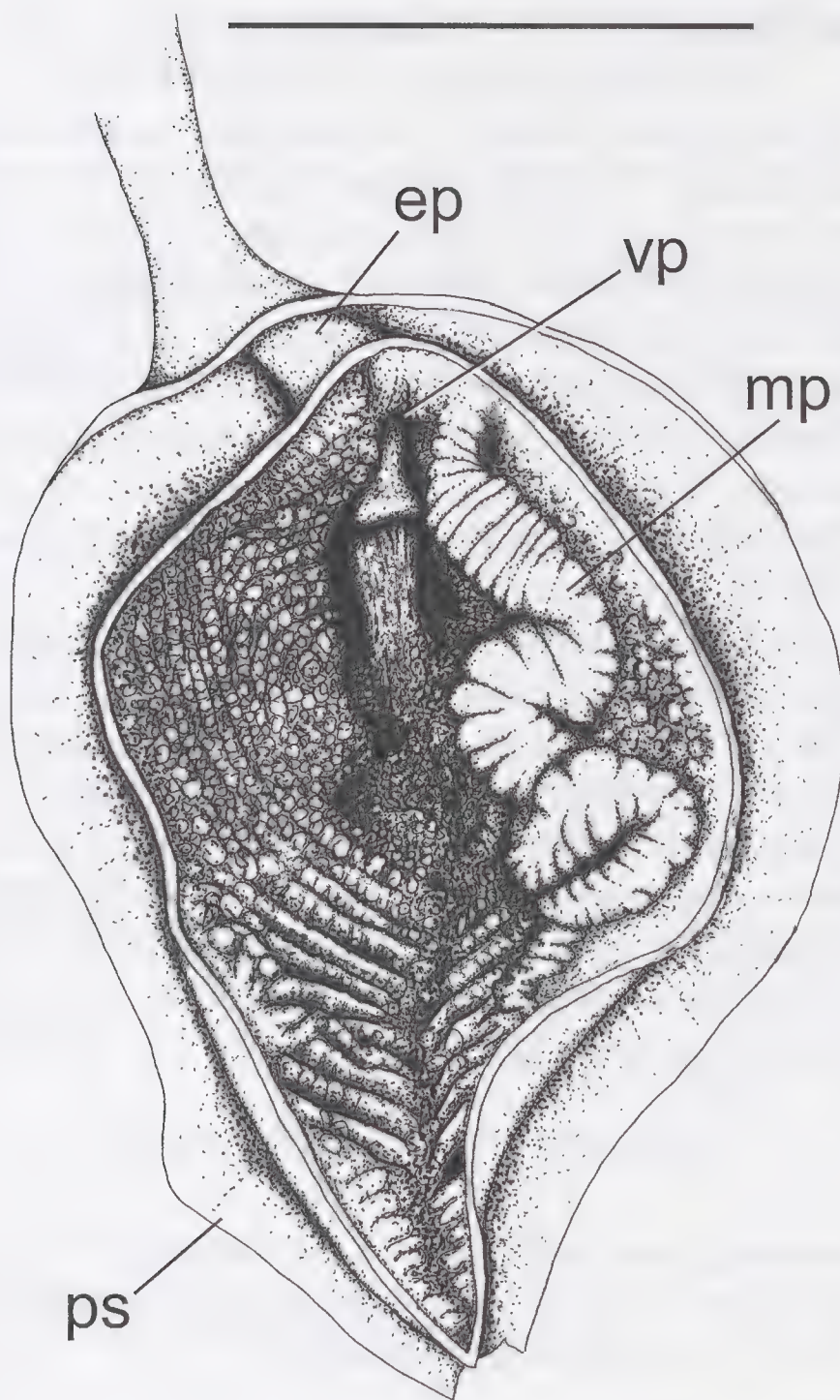


FIG. 40. Penial anatomy of *Kimberleymelon tealei* (WAM S36877, Middle Osborn Island; August). Scale bar = 5 mm.

Type Locality

Western Australia, northwestern Kimberley, Bonaparte Archipelago, Admiralty Gulf, W coast of Middle Osborn Island, 14°18'27.3"S, 125°59'24.7"E.

Material Examined

Holotype WAM S36877 (preserved specimen; Fig. 37F). Paratypes AM C463610 (3 shells), WAM S36489 (4 shells) from 14°18'27.3"S, 125°59'24.7"E; WAM S36490 (shell) from 14°18'37.4"S, 125°59'18.4"E; WAM S36488 (shell) from 14°18'40.0"S, 126°01'29.4"E.

Diagnosis

Shell: (H = 18.3–26.4 mm), whitish colour with diffuse brownish subsutural and peripheral bands that may blend into each other to cover surface

of shell in a light brown tone; apertural lip well rounded, moderately thick, slightly expanded but not reflected; parietal callus well developed, basal and palatal nodules absent (Fig. 37F).

Radula: 3.5–5.5 mm long with 180 rows of teeth; C + 17 + 2 + 25.

Genital anatomy: Penis straight, longer than anterior part of oviduct; penial retractor muscle stubby; inner penial wall with small pilaster next and anterior to vergic papilla, very fine, dense pustulation in fishbone-pattern on entire length of inner penial wall, increasing in size towards anterior base; main stimulatory pilaster well developed, corrugated, undulating, comprising apical to median portion of inner penial wall (Fig. 40). Vagina moderately long, inner wall with densely packed, corrugated longitudinal pilasters.

Comparative Remarks

There are only a few species with similarly large shells, such as *Xanthomelon* and *Globorhagada*. These differ by more globular shell shape, lower spire, yellowish to dark brown colour, much longer penial retractor muscle, lack of epiphallus, and lack of anatomy of main stimulatory pilaster of inner penial wall.

Kimberleydiscus Köhler, 2010

Kimberleydiscus Köhler, 2010b: 10–14. Type species: *Kimberleydiscus fasciatus* Köhler, 2010, by original designation.

Diagnosis

Shell: Comparatively large, discoid, low-spired, moderately thick; umbilicus almost not concealed; protoconch rather smooth with faint radial growth lines; teleoconch with fine radial growth lines, extending onto base of shell; whorls rapidly increasing, flat suture; periphery angulated.

Genital anatomy: Penis with well-developed sheath, extending entire length, thick proximally, thin distally; inner penial wall with pustulation and well-developed main pilaster; epiphallus wanting, simple (= tubular reflection of vas deferens); penial retractor muscle attached to junction of epiphallus with vas deferens. Vas deferens entering penial sheath apically, epiphallus entering penial chamber through simple pore. Bursa copulatrix simple, reaching anterior end of spermoviduct.

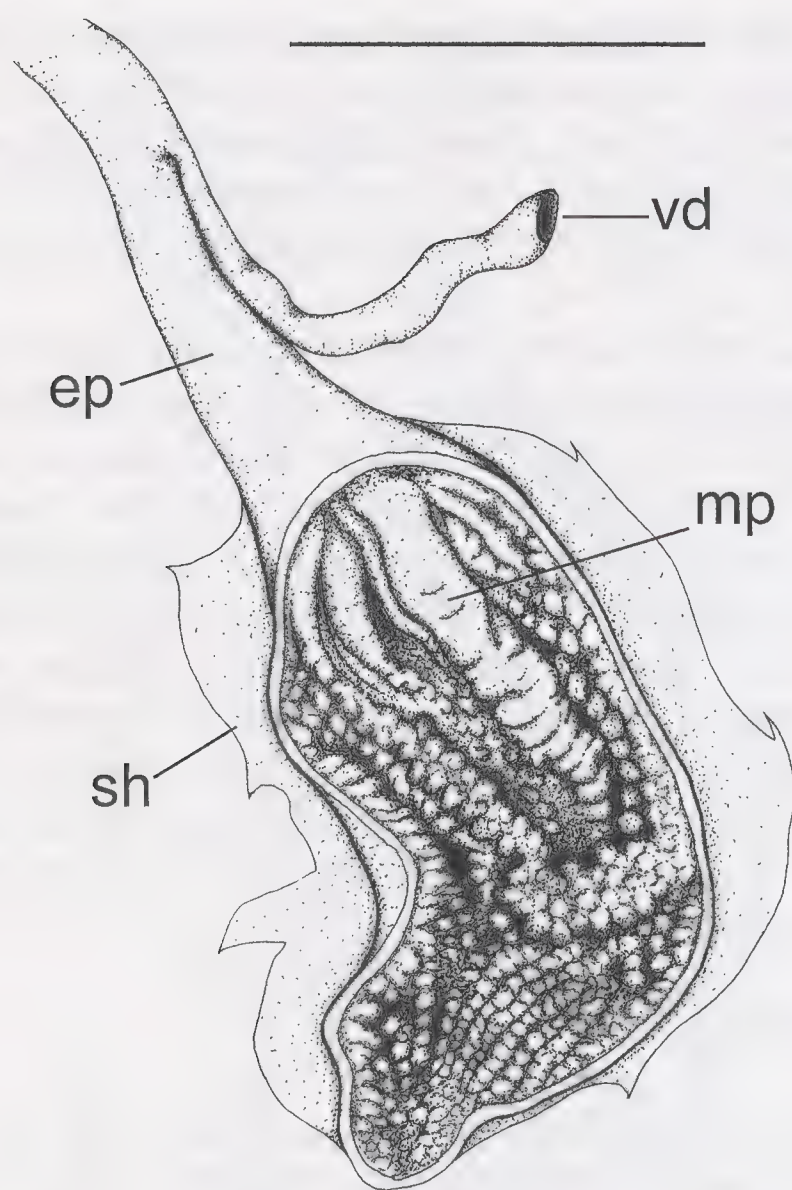


FIG. 41. Penial anatomy of *Kimberleydiscus fasciatus* (AM C463606, Bigge Island; February). Scale bar = 5 mm.

Diversity and Distribution

This monotypic genus is known from Bigge Island only.

Kimberleydiscus fasciatus Köhler, 2010
Figs. 37G, 41

Kimberleydiscus fasciatus Köhler, 2010b:
12–14, figs. 2C, 12–14.

Type Locality

Western Australia, northwestern Kimberley, Bonaparte Archipelago, Bigge Island, 4.4 km NNE of Savage Hill, 14°35'13"S, 125°11'10.5"E.

Material Examined

Holotype WAM S34630 (preserved specimen; Fig. 37G). Paratypes AM C463606 (3 preserved specimens), WAM S36869 (9 preserved specimens) from type locality; WAM S36868 (preserved specimen) from 14°35'20.5"S, 125°11'06.8"E; WAM S36630 (preserved specimen), AM C463608 (5 shells), WAM S36486 (10 shells) from 14°35'33"S, 125°11'19"E.

Diagnosis

Shell: 18–22 mm in diameter, umbilicus comprising 13–20% of shell diameter, 5–20% concealed; colour horn, subsutural and peripheral bands well defined, rather broad, reddish brown; outer lip colour paler than shell; apertural lip simple, sharp, expanded, slightly reflected, parietal callus thin, no basal or palatal nodules (Fig. 37G).

Radula: 3.2–4.5 mm long with 110–140 rows of teeth; C + 13–14 + 3–4 + 20–21.

Genital anatomy: Penis slightly contorted, penial retractor muscle about as long as penis; inner penial wall with conspicuous pustulation, pustules moderate in size, densely arranged in longitudinal rows over entire length of inner penial wall; apical portion of inner penial wall supporting a corrugated main pilaster and some additional shorter, rather indistinct, smooth longitudinal pilasters (Fig. 41).

Australocosmica Köhler, 2011

Australocosmica Köhler, 2011: 199–216. Type species: *Australocosmica augustae* Köhler, 2011, by original designation.

Diagnosis

Shell: Medium sized (D = 13–18 mm; Table 2), moderately thick, broadly conical to subglobose, moderately elevated; umbilicus narrowly winding. Protoconch with weak, radially elongated pustulation. Teleoconch sculptured by strongly developed radial ribs, ribs extent to periphery of whorl being replaced by fine growth lines on base of shell; whorls slowly increasing, separated by deep suture; periphery well rounded to slightly depressed. Shell colour uniform, yellowish brown to brownish-horn; periostracum glossy.

Radula: 3.0–5.5 mm long, with 120–150 rows of teeth, C + 12–14 + 3–4 + 13–16.

Genital anatomy: Penis with well-developed sheath, extending entire length, thick proximally, thin distally; inner penial wall sculpture consists marked of longitudinal pilasters, dense pustulation, or a combination of both; epiphallus lacking; penial retractor muscle attached to junction with vas deferens. Vas deferens entering penial sheath halfway up to almost apically, entering penial chamber through conspicuously thickened, furrowed, collar-like vergic papilla. Bursa copulatrix simple, short (slightly extending anterior end of spermoviduct).

TABLE 2. Shell dimensions of *Australocosmica* (in mm), given are maximum – minimum (mean $\pm$ standard deviation) for N measured specimens.

Species	N	Height (H)	Diameter (D)	Height of Last Whorl (LW)	Whorls	H/D Ratio
<i>A. augustae</i>	15	12.7–16.3 (14.5 $\pm$ 1.1)	15.3–18.2 (16.8 $\pm$ 0.8)	9.8–12.3 (11.1 $\pm$ 0.7)	4.7–5.2 (5.0 $\pm$ 0.2)	0.80–0.93 (0.86 $\pm$ 0.04)
<i>A. sanctumpatriciusae</i>						
Island	12	11.4–13.2 (12.3 $\pm$ 0.5)	15.0–16.4 (15.9 $\pm$ 0.5)	9.2–10.4 (9.6 $\pm$ 0.3)	3.9–4.7 (4.4 $\pm$ 0.2)	0.73–0.82 (0.77 $\pm$ 0.03)
Mainland	17	9.2–12.3 (11.0 $\pm$ 0.7)	14.6–17.8 (15.6 $\pm$ 0.9)	7.8–9.5 (8.8 $\pm$ 0.4)	4.2–4.6 (4.4 $\pm$ 0.1)	0.63–0.76 (0.71 $\pm$ 0.04)
<i>A. vulcanica</i>	32	9.4–11.5 (10.4 $\pm$ 0.6)	13.1–15.0 (13.8 $\pm$ 0.4)	7.6–9.0 (8.3 $\pm$ 0.3)	3.7–4.7 (4.3 $\pm$ 0.2)	0.69–0.81 (0.75 $\pm$ 0.03)
spec. A	6	12.9–14.6 (13.4 $\pm$ 0.6)	14.6–16.7 (15.3 $\pm$ 0.7)	9.7–11.0 (10.2 $\pm$ 0.5)	4.5–5.2 (4.7 $\pm$ 0.2)	0.81–0.95 (0.87 $\pm$ 0.04)
spec. B	2	14.0–14.8 (14.4 $\pm$ 0.4)	17.7–17.8 (17.8 $\pm$ 0.1)	11.2–11.7 (11.5 $\pm$ 0.3)	4.6–5.6 (5.1 $\pm$ 0.5)	0.79–0.84 (0.81 $\pm$ 0.02)



FIG. 42. Distribution map of *Carinotrachia*, *Kimberleymelon*, *Kimberleydiscus* and *Australocosmica*: + = *Carinotrachia admirale admirale* and *Kimberleymelon tealei* (Middle Osborn Island); ■ = *Carinotrachia admirale admirale* (Southwest Osborn Island); * = *Kimberleydiscus fasciatus* (Bigge Island); circles = records of *Australocosmica* species treated herein: 1: *A. sanctumpatriciusae* (St. Patrick Island and opposite mainland), 2: *A. augustae* (Augustus Island), 3: *A. vulcanica* (unnamed island in Vulcan Islands); triangles = records of undescribed species listed herein: A: *Australocosmica* spec. A (D'Arcy Island), B: *Australocosmica* spec. B (Coronation Island), C: *Australocosmica* spec. C (mainland, 1.3 km S of Halfway Bay); diamonds = records of undescribed *Australocosmica* species listed by Solem (1991).

Aestivation Strategy

Free sealer.

Diversity and Distribution (Fig. 42)

Currently known only from coastal portions of the mainland along the gulfs of St. George Basin and George Water, Prince Regent region, as well as from various islands in York and Camden sounds, Brunswick and Hanover bays. Next to three species described by Köhler (2011), seven additional, yet undescribed species were collected at various locations; material deposited with the Field Museum, Chicago (species 39, 40, 76–80 preliminarily identified by Alan Solem). In addition, three further undescribed species were collected during the Kimberley Island Survey but lack of preserved material prevented formal description: “spec. A” from D’Arcy Island, “spec. B” from Coronation Island, “spec. C” from mainland near Halfway Bay (Köhler, 2011). One undescribed species was collected on an unnamed island near the mouth of Sale River, Doubtful Bay, by Vince Kessner in 2010. Consequently, in addition to the three named species, there are probably at least 11 undescribed species.

Australocosmica augustae Köhler, 2011
Figs. 37H, 43

Australocosmica augustae Köhler, 2011: 204–206, figs. 2A, 3–5.

Type Locality

Western Australia, central Kimberley coast, Bonaparte Archipelago, Camden Sound, NW section of Augustus Island, 15°20'11"S, 124°31'10"E (KIS 1–67).

Material Examined

Holotype WAM S34667 (preserved specimen, Fig. 37H). Paratypes WAM S37635 (10 preserved specimens), AM C465175 (5 preserved specimens). Additional, non-type material WAM S37633 (preserved juvenile), WAM S49023 (8 shells) from southern section, 15°23'52"S, 124°38'30"E; WAM S37634 (preserved specimen), AM C465176 (5 shells) from SE section, 15°23'45"S, 124°37'47"E.

Diagnosis

Shell: 13–16 mm in height, 15–18 mm in diameter (Table 2), thin (translucent) in juve-

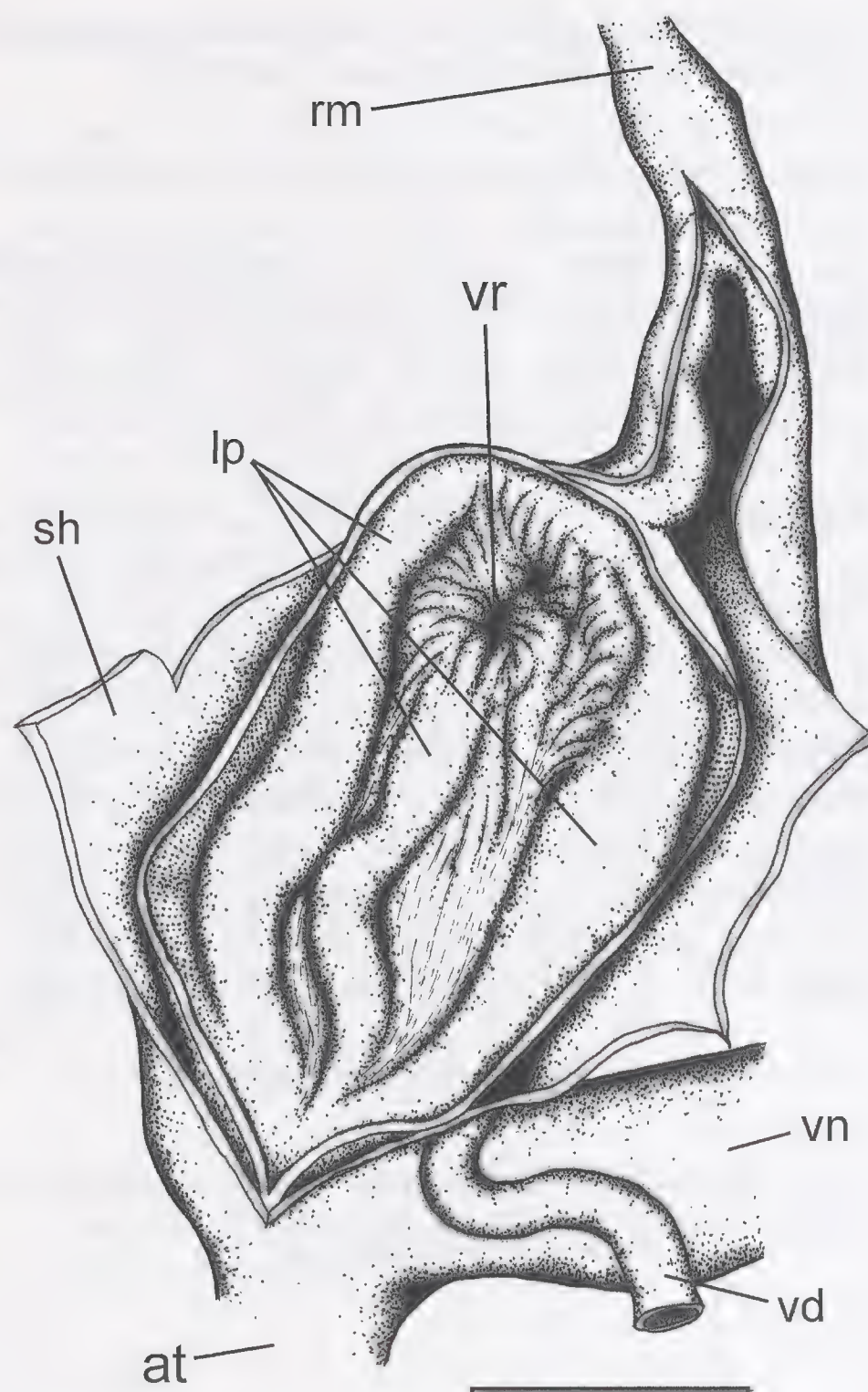


FIG. 43. Penial anatomy of *Australocosmica augustae* (AM C465175, Augustus Island, February). Scale bar = 1 mm.

niles, thick in adults; whorls slightly shouldered underneath suture; inner lip colour whitish; aperture with thinly callused parietal wall, forming an angle of 45° in adults, 30° in juveniles; outer lip thin, slightly expanded; protoconch ~ 3.5 mm in diameter with 1.5 whorls, with very fine, indistinct axial pustulation (Fig. 37H).

Genital anatomy: Penis straight, as long as anterior part of oviduct; penial retractor muscle longer than penis; inner penial wall smooth, three longitudinal pilasters forming along entire length of inner penial, two on each side of vergic ring, a third shorter, weaker underneath vergic opening (Fig. 43). Vagina moderately long, posteriorly inflated; inner wall with two or three smooth longitudinal pilasters.

Distribution and Ecology (Fig. 42)

Endemic to Augustus Island; found in vine thickets active on ground (leg. V. Kessner, 13.02.2009).

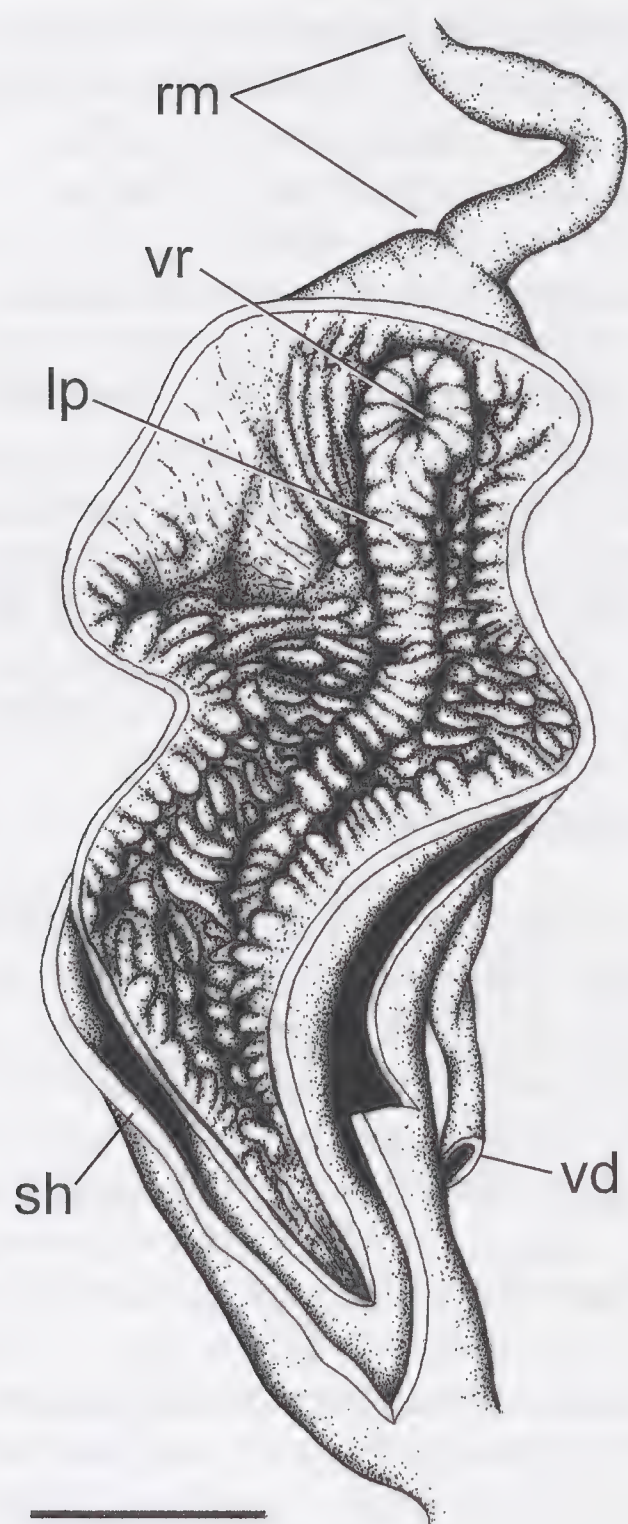


FIG. 44. Penial anatomy of *Australocosmica sanctumpatriciusae* (WAM S37637, St Patrick Island, February). Scale bar = 1 mm.

Australocosmica sanctumpatriciusae
Köhler, 2011
Figs. 37I, 44

Australocosmica sanctumpatriciusae Köhler, 2011: 206–208, figs. 2B, C, 6–8.

Type Locality

Western Australia, central Kimberley coast, Saint George Basin, St. Patrick Island, 15°21'23"S, 124°57'55"E (KIS 2–64).

Material Examined

Holotype WAM S37666 (preserved specimen, Fig. 37I). Paratypes WAM S37637 (2 preserved specimens), WAM S49021 (6 shells), AM C465173 (5 shells) from type locality.

Further, non-type material WAM S37638 (3 preserved specimens), WAM S49022 (13 shells), AM C465174 (5 shells) from small peninsula ca. 8 km SE of St. Patrick Island, 15°26'02"S, 125°00'23"E.

Diagnosis

Shell: 11–13 mm in height, 15–16 mm in diameter (Table 2), thin; whorls moderately wide in cross-section, slightly shouldered underneath suture, periphery well rounded to slightly angulated; teleoconch with very thin, dense, regularly spaced radial ribs; inner lip whitish; with thinly callused parietal wall, angle of aperture 60°; outer lip thin, very slightly expanded; umbilicus forming chink; protoconch ~ 2.5 mm in diameter, ~ 1.5 whorls, with very fine, indistinct axial pustulation (Fig. 37I).

Genital anatomy: Penis as long as anterior part of oviduct, penial retractor muscle about as long as penis, proximal end of inner penial wall with obliquely arranged, fine, irregular transversal folds being distally replaced by rather large, rhomboid pustules that comprise most of wall; a well-developed, corrugated pilaster forms anteriorly of vergic opening (Fig. 44). Inner wall of vagina and anterior oviduct with many delicate longitudinal pilasters. Bursa copulatrix short.

Comparative Remarks

Shell shape and size are intermediate between *A. augustae* and *A. vulcanica*. Topotypic specimens with smaller and flatter shell than *A. augustae*, larger than *A. vulcanica*. In topotypic specimens umbilicus forms a chink like in *A. augustae* but unlike *A. vulcanica*. Dense pustulation of entire penial wall and presence of a corrugated pilaster underneath vergic opening being the most distinctive feature. Specimens from mainland with slightly smaller shells, narrowly winding umbilicus (like *A. vulcanica*), but similar penial morphology and genetically not well differentiated are considered to be conspecific.

Distribution and Ecology (Fig. 42)

Found on St. Patrick Island and adjacent mainland (small peninsula ca. 8 km SE of St. Patrick Island) in vine thickets, among sandstone boulders, under rocks and in loose soil.

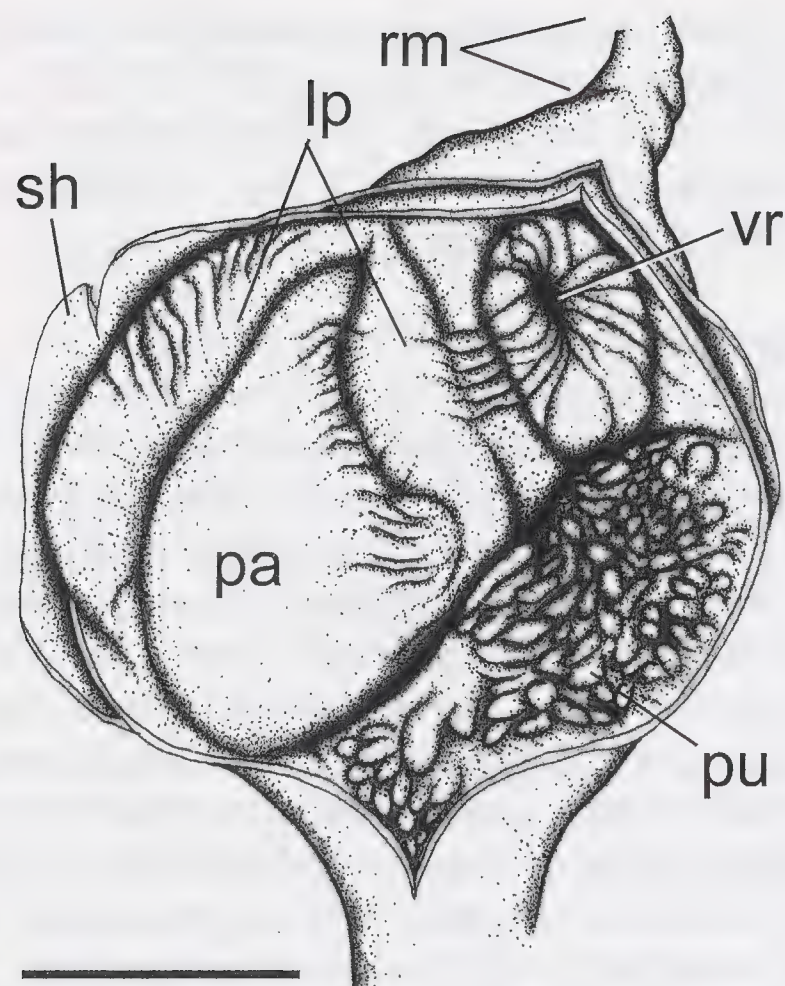


FIG. 45. Penial anatomy of *Australocosmica vulcanica* (AM C465177, unnamed island in Vulcan Islands group, February). Scale bar = 1 mm.

Australocosmica vulcanica Köhler, 2011
Figs. 37J, 45

Australocosmica vulcanica Köhler, 2011:
209–211, figs. 2D, 9–11.

Type Locality

Western Australia, central Kimberley coast, Bonaparte Archipelago, unnamed island in Vulcan Islands, 1.4 km from NE corner of D'Arcy Island, 15°15'26"S, 124°24'22"E (KIS 2–63).

Material Examined

Holotype WAM S37668 (preserved specimen, Fig. 37J). Paratypes WAM S37636 (18 preserved specimens), AM C465177 (5 preserved specimens), WAM S49020 (13 shells), AM C465178 (10 shells) from type locality.

Description

Shell: Height 9–11 mm, diameter 13–15 mm (Table 2), thin; yellowish brown, inner lip whitish; whorls moderately wide in cross-section, well rounded to slightly angulated at periphery, slightly shouldered underneath suture; sculpture consists of very thin, dense, regularly spaced axial ribs; outer lip thin, very slightly expanded; umbilicus narrowly open or forming

a chink; angle of aperture 60°; protoconch ~ 2.5 mm in diameter with ~ 1.5 whorls, with very fine, indistinct axial pustulation (Fig. 37J).

Genital anatomy: Penis strongly inflated, clearly shorter than anterior part of oviduct; penial retractor muscle about as long as penis; parts of inner penial wall pad-like thickened, smooth, delimited by two thick, smooth longitudinal pilasters, distally with dense pustulation; pustules rather large, irregularly arranged (Fig. 45). Vagina moderately long, tubular; inner wall of vagina and anterior oviduct with two to three smooth longitudinal pilasters. Bursa copulatrix short.

Comparative Remarks

Shell smaller, flatter, with finer sculpture than *A. augustae* and smaller than *A. sanctumpatriciusae* (Table 2). Umbilicus narrowly winding instead of being entirely concealed as in *A. augustae*. Inflated penis proper and pad-like thickening of inner penial wall are diagnostic.

Distribution and Ecology (Fig. 42)

Only known from type locality where it is common in vine thickets on volcanic scree, in leaf litter and amongst boulders. Shells from D'Arcy Island appear to be larger and more elevated; their species identity remaining unclear (Köhler, 2011).

Kimboraga Iredale, 1939

Kimboraga Iredale, 1939: 47; Solem, 1985a: 818–846; 1991: 210–213; Solem & McKenzie, 1991: 247–263. Type species: *Chloritis micromphala* Gude, 1907, by original designation.

Taxonomic Remarks

The name *Kimboraga* was first used as *nomen nudum* by Iredale (1933, 1938) before being validly described by Iredale (1939); see Solem (1985a).

Diagnosis

Shell: Medium sized to large (D = 15–25 mm; Table 3), thin to moderately thick, conical to almost globose, moderately to strongly elevated; umbilicus narrowly winding, partly to almost completely concealed; protoconch rather smooth, with weakly developed radial growth lines, exceptionally with very weak radial pus-

TABLE 3. Shell parameters of *Kimboraga* (in mm), given are maximum – minimum (mean ± standard deviation) for N measured specimens. Abbreviations used: HT = holotype.

Species	N	Height (H)	Diameter (D)	Height of Last Whorl (LW)	Whorls	H/D Ratio
<i>K. glabra</i> n. sp.	HT	13.9	21.6	10.3	4.0	0.64
	13	12.5–14.0 (13.2 ± 0.5)	19.5–21.8 (20.6 ± 0.7)	9.3–10.5 (9.9 ± 0.3)	3.8–4.2 (4.0 ± 0.1)	0.61–0.70 (0.64 ± 0.02)
<i>K. exanima</i>	12	14.3–18.3 (17.3 ± 1.1)	19.0–22.0 (21.0 ± 0.8)	10.8–13.2 (12.6 ± 0.6)	2.9–3.7 (3.3 ± 0.2)	0.75–0.91 (0.83 ± 0.04)
<i>K. wulalam</i> n. sp.	HT	18.5	23.7	13.3	3.9	0.78
	13	17.1–19.0 (18.2 ± 0.5)	22.4–24.3 (23.6 ± 0.5)	12.5–13.5 (13.0 ± 0.3)	3.7–4.2 (3.9 ± 0.1)	0.71–0.83 (0.77 ± 0.03)
<i>K. cascadenis</i> n. sp.	HT	17.2	22	13	3.8	0.78
	12	14.0–18.5 (16.4 ± 1.4)	19.2–24.0 (21.6 ± 1.5)	10.0–13.0 (11.8 ± 0.9)	3.5–4.1 (3.8 ± 0.2)	0.73–0.79 (0.76 ± 0.02)

tulation; teleoconch sculptured by very weak to well-developed, narrowly arranged radial ribs that continue onto the shell base; whorls rapidly increasing, separated by moderately deep to deep suture; periphery well rounded to slightly

depressed. Shell colour more or less uniform, yellowish brown to brown, some species with reddish-purple suffusion, no colour banding.
Radula: ~ 3.0 mm long, C + 12–14 + 2–3 + 16–20.

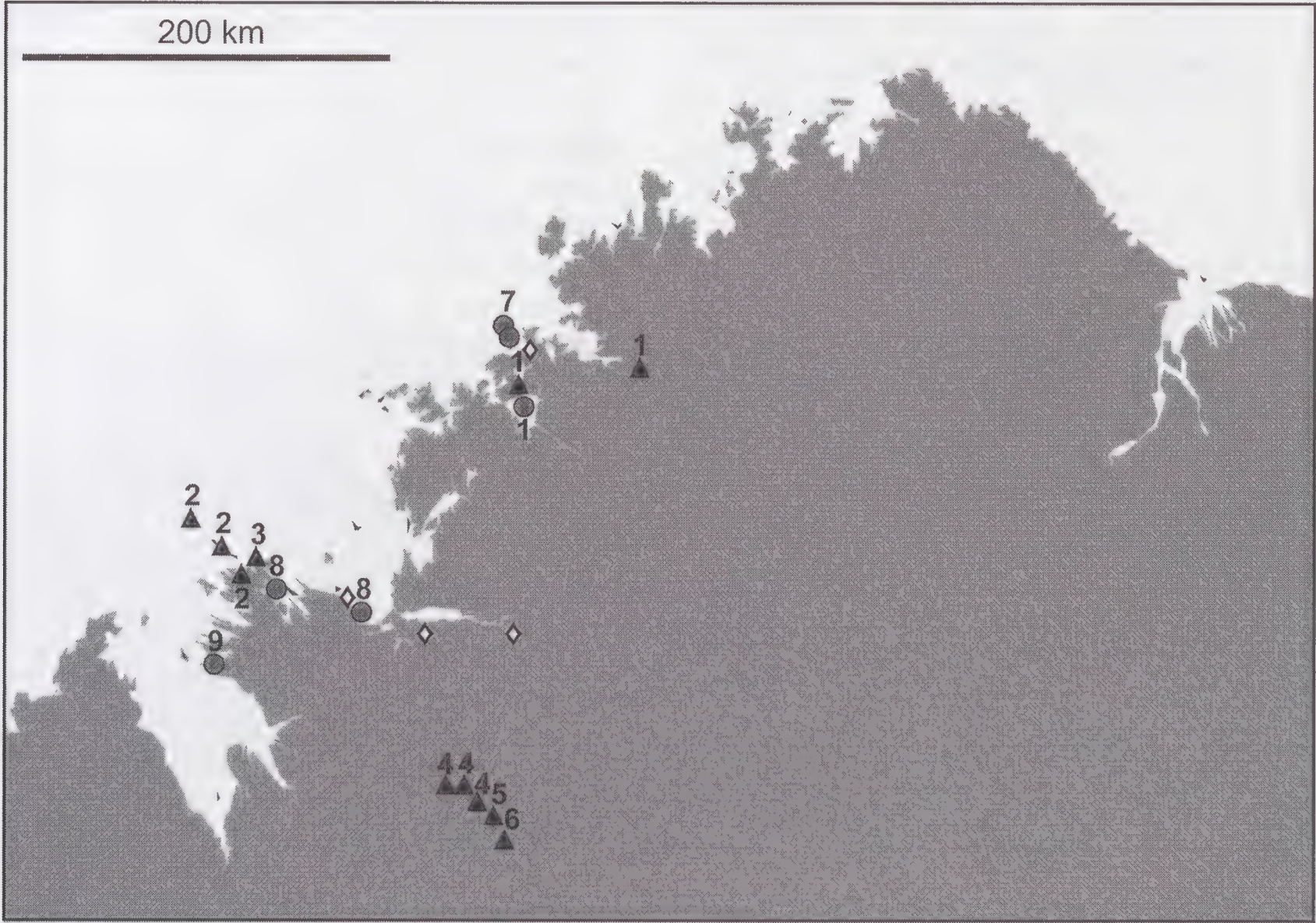


FIG. 46. Distribution map of *Kimboraga*. Circles = Records of species treated herein; triangles = species treated by Solem (1985, 1991); diamonds = records of undescribed taxa listed by Solem (1991): 1: *K. exanima*, 2: *K. yampiensis*, 3: *K. koolanensis*, 4: *K. mccorrii*, 5: *K. micromphalla*, 6: *K. yammerana*, 7: *K. glabra* n. sp., 8: *K. wulalam* n. sp., 9: *K. cascadenis* n. sp.

Genital anatomy: Penis with well-developed sheath, extending entire length, thick proximally, thin distally; inner penial wall sculpture consisting of rhomboid, relatively large pustules; epiphallus lacking; penial retractor muscle attached to junction with vas deferens. Vas deferens entering penial sheath in proximal third of penial complex, entering penial chamber through simple, vergic ring or cone-shaped verge. Bursa copulatrix simple varying in length, with inflated head, reaching or extending base of spermoviduct.

Aestivation Strategy

Rock sealer (modified after Solem, 1985a).

Diversity and Distribution (Fig. 46)

According to Solem (1985a), the genus currently contains six named species from Napier Ranges (three species), Prince Regent Reserve (one species), Yampi Sound (one or two species). In addition, Solem (1991) listed three undescribed species (NSP11, NSP12, NSP41) from SW Collier Bay and Walcott Inlet, as well as Cape Brewster. In the following four species are being newly described from Coronation, St. Patrick, Wulalam and Lachlan Islands.

***Kimboraga glabra* n. sp.**
Figs. 37K, 47A, B

Type Locality

Western Australia, central Kimberley coast, Bonaparte Archipelago, southern section of Coronation Island, 15°01'59"S, 124°57'15"E;

coll. Vince Kessner, 2/06/2008, KIS 3–93 (vine thicket on upper SE-facing slopes, volcanic scree at base of cliffs and in crevices).

Material Examined

Holotype WAM S58437 (shell; Fig. 37K, Table 3). Paratypes AM C471723 (2 shells), WAM S37178 (4 shells) from type locality; WAM S37175 (shell) from 15°01'59"S, 124°56'53"E; WAM S37176 (9 shells) from 15°01'27"S, 124°56'28"E; WAM S37177 (shell) from 15°01'45"S, 124°56'49"E; AM C471724 (2 shells), WAM S49038 (2 shells) from 15°02'08.3"S, 124°57'06.1"E.

Etymology

From "*glaber*" (Latin, masculine = smooth), in reference to the characteristically smooth shell; adjective of feminine gender.

Description

Shell (Figs. 37K, 47A, B): Medium sized ($D = 19.5\text{--}21.8$ mm; Table 3), rather thin (translucent), broadly conical with low spire. Last whorl relatively narrow in cross-section, with well-rounded periphery, slightly depressed underneath well-incised suture. Umbilicus narrowly open, partly concealed. Protoconch with very weak radial pustulation. Teleoconch with very weak, narrowly arranged radial growth lines, most prominent on last whorl. Shell colour uniform, yellowish to reddish brown, with glossy surface. Aperture moderately wide, with simple, expanded lip, palatal or distal nodules absent, parietal wall inconspicuous.

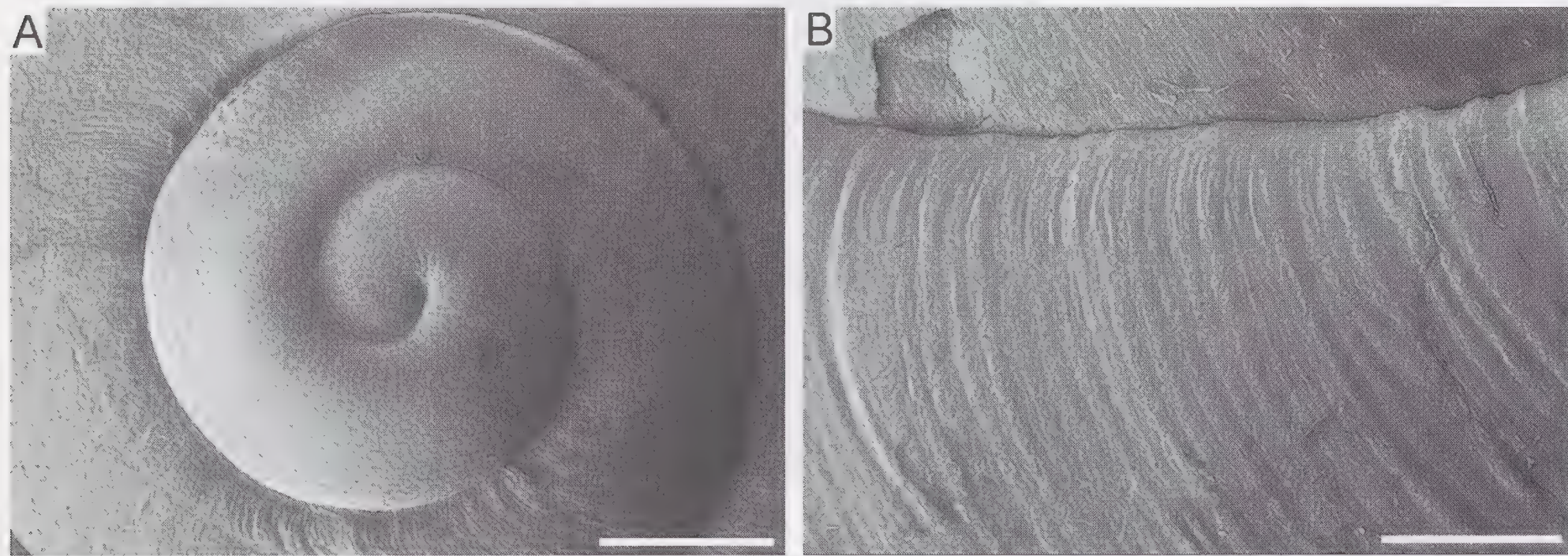


FIG. 47. SEM micrographs of the shell of *Kimboraga glabra* n. sp. paratype AM C471724 (Coronation island). A: Apical view showing protoconch; B: Details of sculpture on last whorl underneath suture. Scale bars = 1 mm.

Comparative Remarks

Known from dry shells only; differing from all other species by its broadly conical, low-spired shell, uninflated last whorl, glossy surface, absence of well-developed sculpture. It may well be identical with "*Kimboraga* NSP41" listed by Solem (1991), which was found on unnamed island in York Sound near Cape Brewster, immediately south of Coronation Island (RFS 12/2).

Distribution

Coronation Island, York Sound and possibly islands immediately south of Coronation Island.

Kimboraga exanima Solem, 1985
Figs. 37L, 48–50

Kimboraga exanimus [sic] Solem, 1985a:
835–836, figs. 205a–c.

Type Locality

Western Australia, central Kimberley coast, Saint George Basin, Prince Regent River Reserve, below eastern face of Mt. Trafalgar, 15°17'S, 125°04'E.

Material Examined

From St. Andrews Island, George Basin:
WAM S36695 (18 preserved specimens),
AM C471725 (10 preserved specimens)

from 15°21'24"S, 124°59'46"E; WAM S37621 (26 preserved specimens), AM C471726 (3 shells), WAM S49016 (5 shells), WAM S37415 (4 shells) from 15°21'22.7"S, 124°59'50"E; WAM S37622 (31 preserved specimens), AM C471727 (15 preserved specimens) from 15°21'29.5"S, 124°59'51.1"E; WAM S37605 (2 shells) from 15°21'26"S, 124°59'48"E.

Taxonomic Remarks

The species epithet "*exanimus*" (Latin = lifeless) introduced by Solem (1985) is an adjective. Because *Kimboraga* is of feminine gender, the correct name for this species is "*exanima*". Description based on dried shells from near Mt. Trafalgar; also reported from other mainland localities in NW Prince Regent Reserve (Solem, 1985a, 1991) (Fig. 46). Its anatomy has so far remained unknown. Material from St. Andrews Island, close to the type locality on opposite mainland, is preliminarily assigned to this species for a similar shell.

Description

Shell (Figs. 37L, 48A, B): Medium sized ($D = 19\text{--}22$ mm; Table 3), robust, conical with strongly elevated spire. Umbilicus almost completely concealed. Protoconch almost entirely smooth with very subtle radial growth lines. Teleoconch with well-developed, narrowly arranged radial growth lines, triangular in cross-section, evenly distributed across shell surface. Last whorl wide in cross-section, moderately

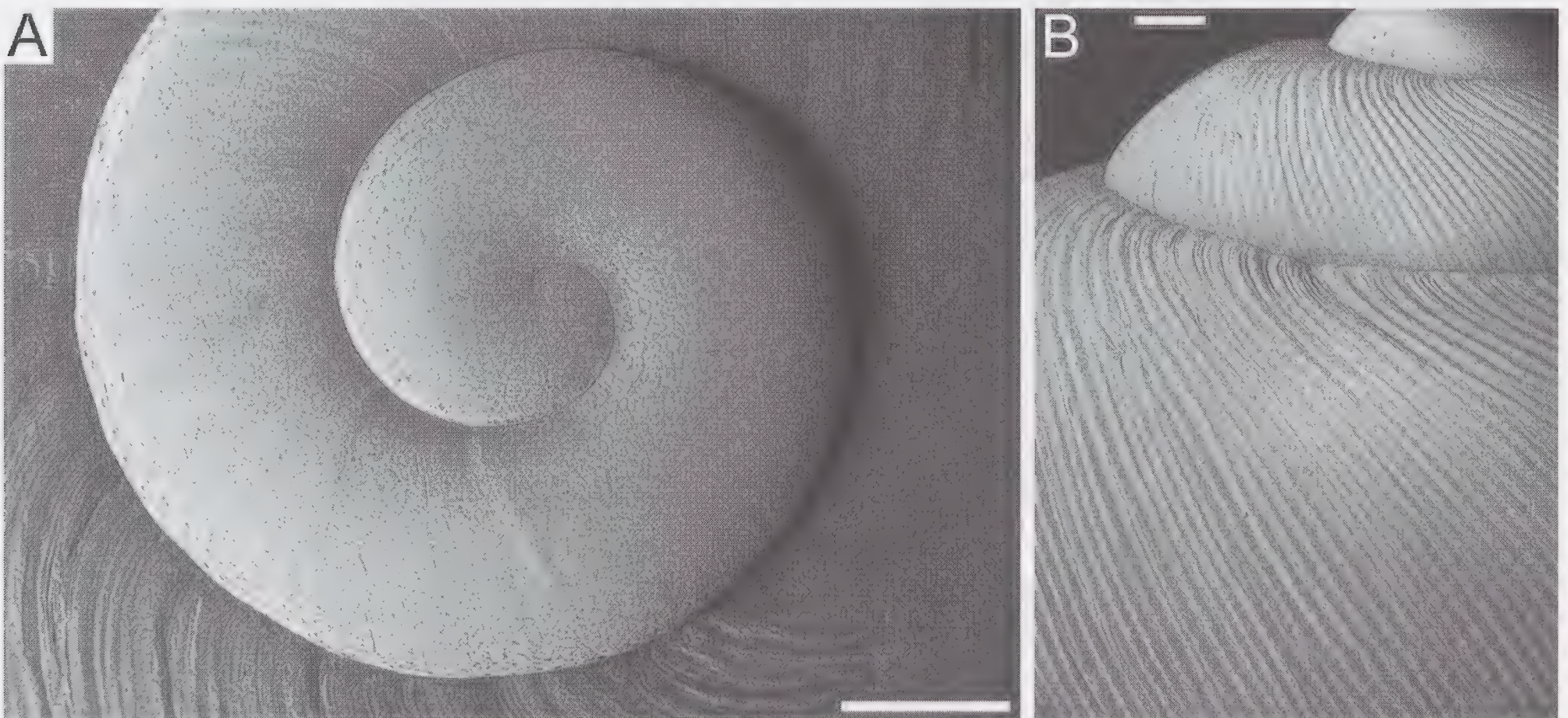


FIG. 48. SEM photographs of the shell of *Kimboraga exanima* AM C471726 (St Andrews Island). A: Apical view; B: Details of sculpture on first and second whorl. Scale bars = 1 mm.

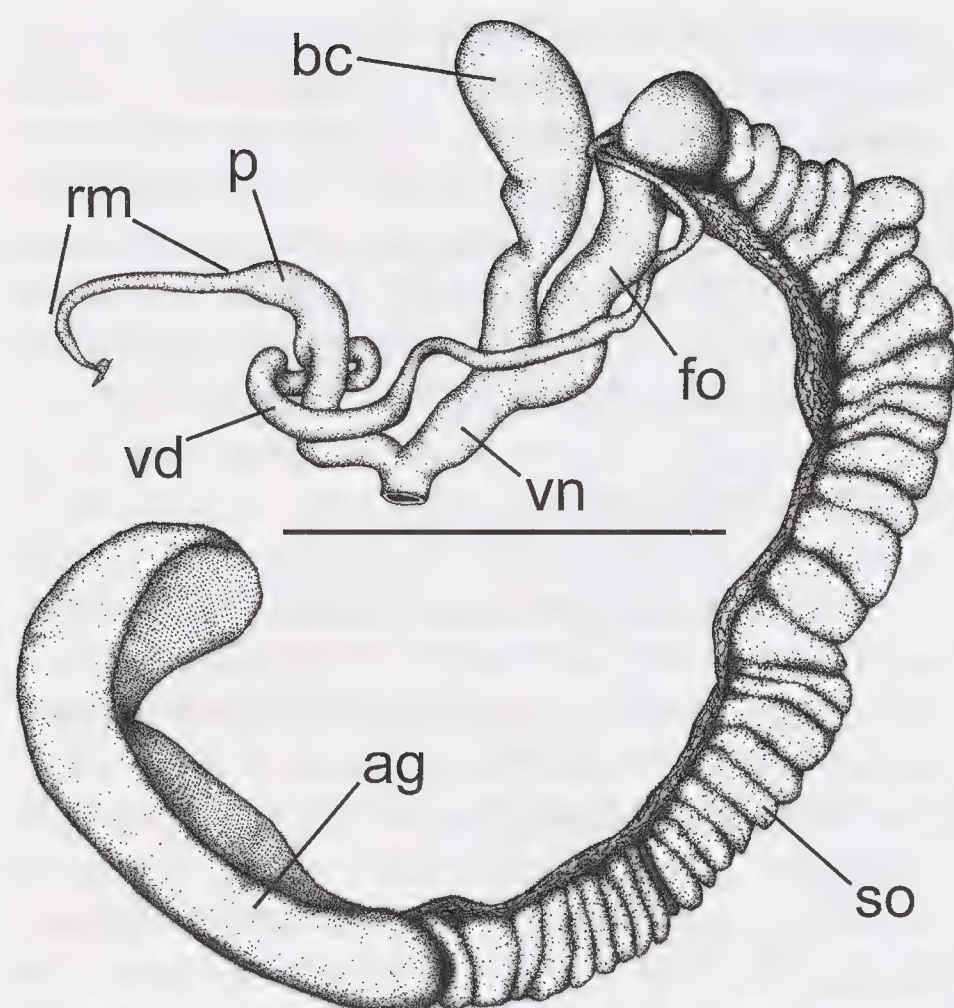


FIG. 49. Genital anatomy of *Kimboraga exanima* AM C471727 (St Andrews Island, May). Scale bar = 10 mm.

inflated, with well-rounded periphery, not depressed underneath well-incised suture. Shell colour blends from lighter yellowish brown at the tip to dark reddish brown on last whorl, base of shell brownish to yellowish horn, with glossy surface. Aperture wide, inside reddish brown with white outer margin, with simple, expanded lip, palatal or distal nodules absent, parietal wall slightly callused.

Genital anatomy (Figs. 49–50): Penis very small, very narrow, tubular (thinner than vas deferens!), coiled within thick penial sheath; penial complex about as long as vagina; penial retractor muscle same length as penial complex. Vas deferens comparatively thick. Inner penial wall supporting sparsely distributed, rhomboid pustules. Vagina moderately short. Bursa copulatrix short, reaching base of spermoviduct.

Comparative Remarks

Shells from St. Andrews Island differ from type specimens in larger size, slightly lower H/D ratio and lower whorl number. *Kimboraga exanima* differs from *K. glabra* by much stronger elevation (different H/D ratio), lower number of whorls, stronger sculpture, darker colour and more inflated last whorl (Table 3). Genitalia differ from all other species most conspicuously by narrowly tubular penis with sparse pustulation of inner penial wall.

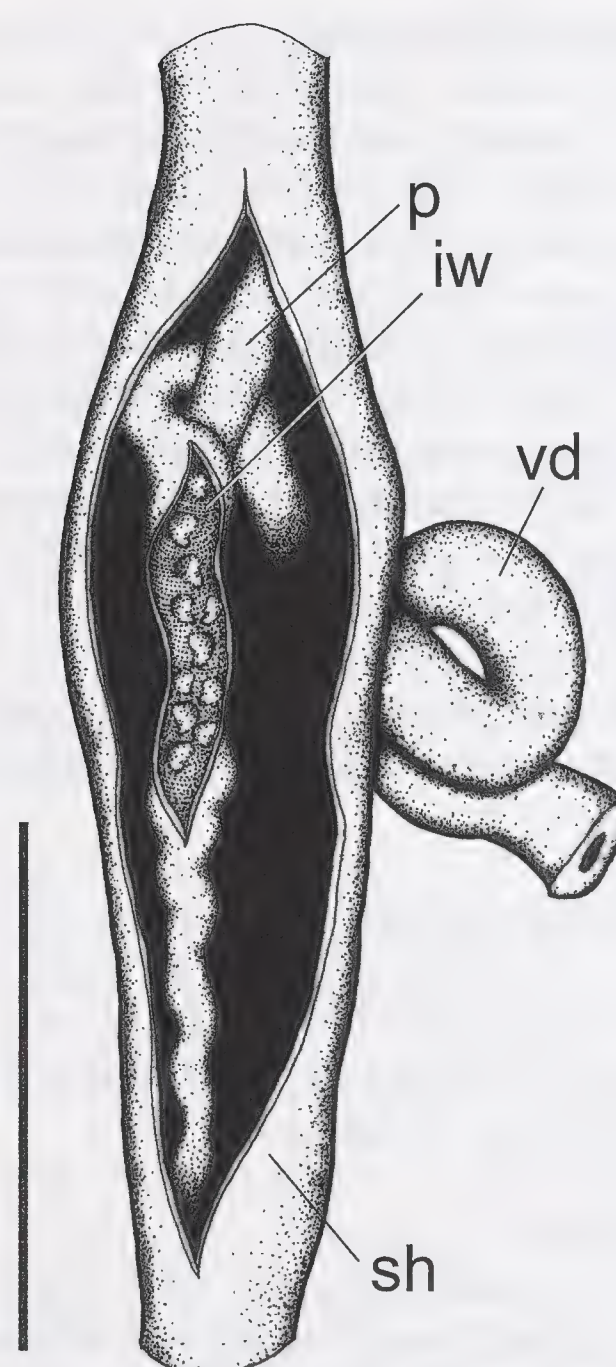


FIG. 50. Penial anatomy of *Kimboraga exanima* AM C471727 (St Andrews Island, May). Scale bar = 2 mm.

Distribution (Fig. 46)

Northwestern parts of Prince Regent Reserve and St. Andrews Island, Saint George Basin.

Kimboraga wulalam n. sp. Figs. 37M, 51A–C, 52, 53

Type Locality

Western Australia, southwest Kimberley coast, Collier Bay, Wulalam Island, 16°22'13.4"S, 124°13'46.7"E; coll. Sean Stankowskii, 22/05/2009, KIS 2–73 (cliff face with scree, at base of creek line, in scree piles).

Material Examined

Holotype WAM S58438 (preserved specimen, Fig. 37M, Table 3). Paratypes WAM S37731 (20 preserved specimens), AM C471728 (10 preserved specimens), WAM S37824 (4 shells)

from type locality; WAM S37732 (preserved specimen) from 16°21'56.8"S, 124°13'45.7"E; WAM S37733 (6 preserved specimens) from 16°22'18"S, 124°14'05"E; WAM S37793 (6 preserved specimens), WAM S37823 (3 shells) from 16°22'24.6"S, 124°13'52.5"E; WAM S49244 (11 preserved specimens) from 16°22'15.6"S, 124°13'45.3"E.

Additional non-type material. WAM S49245 (59 preserved specimens), AM C471729 (20 preserved specimens) from small, unnamed island N of Wulalam Island, 16°20'33"S, 124°13'36"E; WAM S49246 (108 preserved specimens), AM C471730 (70 preserved specimens) from small island E of Molema Island, Talbot Bay, 16°14'04"S, 123°50'36"E.

Etymology

For Wulalam Island, noun in apposition.

Description

Shell (Figs. 37M, 51A–C): Medium sized ($D = 22\text{--}25\text{ mm}$, Table 3), robust, conical with moderately elevated spire. Umbilicus almost completely concealed. Protoconch with very subtle radial growth lines. Teleoconch with well-developed, narrowly arranged radial growth lines, triangular in cross-section, evenly distributed across shell surface. Last whorl wide in cross-section, moderately inflated, with well-rounded periphery, not depressed underneath well-incised suture. Shell colour blends from lighter yellowish brown at tip to dark reddish brown on last whorl, base of shell brownish to yellowish horn, with glossy surface. Aperture wide, inside whitish, with simple, slightly expanded lip, palatal or distal nodules absent, parietal wall inconspicuous.

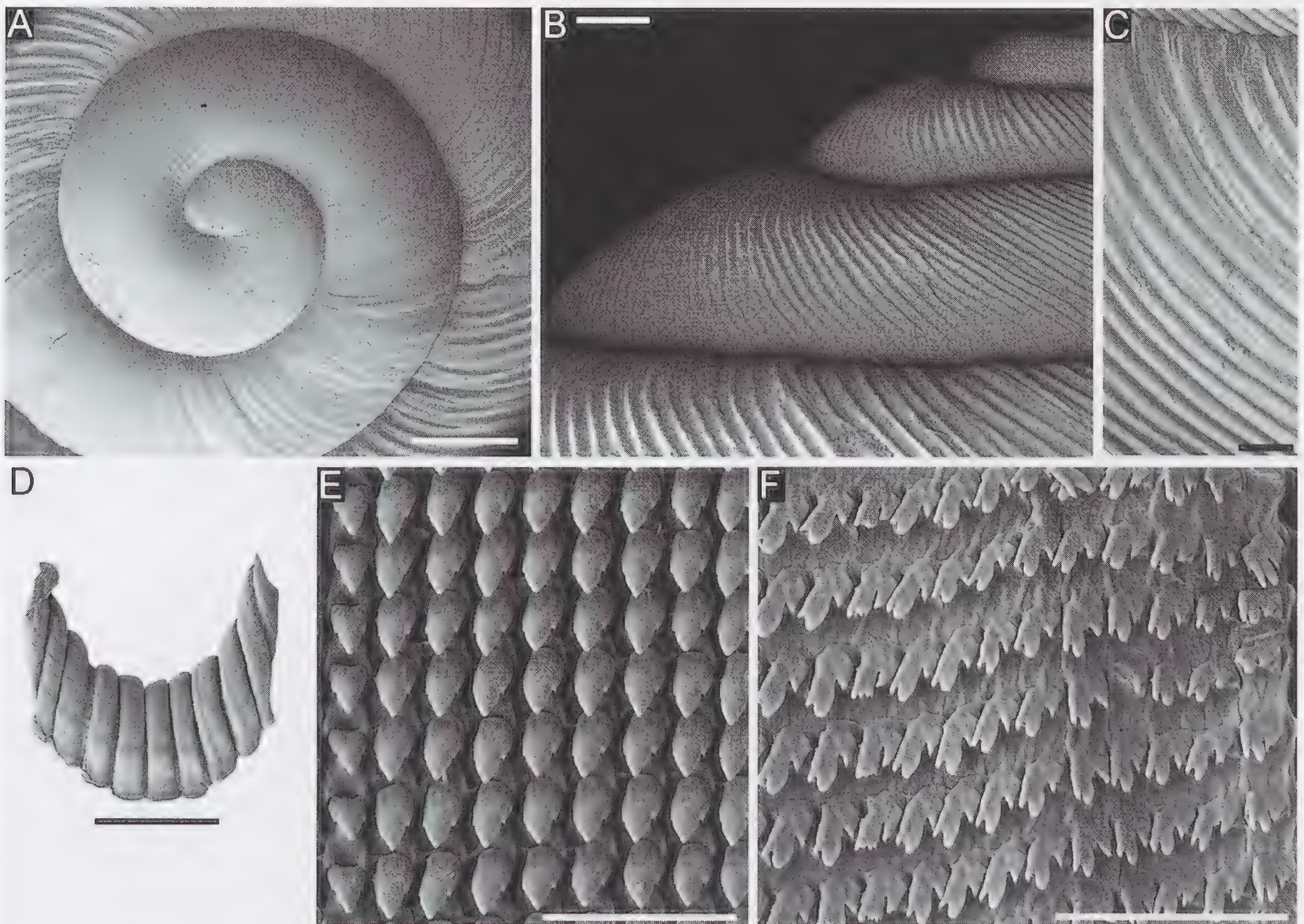


FIG. 51. SEM micrographs of *Kimboraga wulalam* n. sp. (Wulalam Island). A–C: Shell, paratype AM C471728. A: Apical view showing protoconch; B: Lateral view showing sculpture on first to third whorl; C: Detail of sculpture on first whorl. Scale bars A–B = 1 mm, C = 0.5 mm. D: Jaw, paratype WAM S37793. Scale bar = 0.5 mm. E–F: Radula, paratype WAM S37793; E: Central and inner lateral teeth viewed from above; F: Close-up of inner to middle marginal teeth. Scale bars = 100 µm.

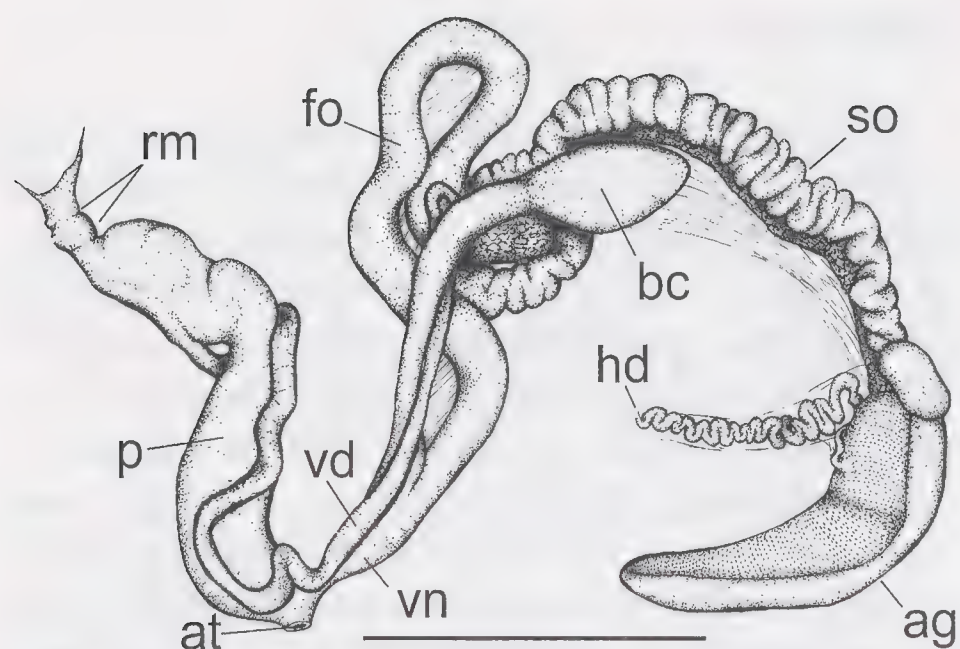


FIG. 52. Genital anatomy of *Kimboraga wulalam* n. sp. paratype AM C471728 (Wulalam Island, May). Scale bar = 10 mm.

Digestive anatomy: Jaw with 11 regular plates (Fig. 51D). Radula 5.5 mm long with 120–170 rows of teeth; C + 10 + 4 + 16 (Fig. 51E–F).

Genital anatomy (Figs. 52–53): Penis moderate in size, narrowly tubular (thicker than vas deferens), coiled within thick penial sheath; penial complex about as long as vagina; penial retractor muscle stubby. Vas deferens comparatively thick, entering sheath near apex of penial complex, entering lumen of penial chamber through a tubular verge. Inner penial wall supporting densely packed, rhomboid pustules over entire length. Vagina rather short. Bursa copulatrix moderately long, extending base of spermoviduct.

Comparative Remarks

Shell differs from *K. glabra* by stronger elevation, stronger sculpture and more inflated last whorl; from *K. exanima* by larger size, more whorls, less elevated spire and white colour of inner lip (Table 3). Genitalia differ from other species most conspicuously by presence of well-developed penial verge, from *K. exanima* by thicker size of penis and stronger pustulation of penial wall.

Distribution (Fig. 46)

Wulalam Island in Collier Bay and Molema Island plus unnamed island in Talbot Bay.

Kimboraga cascadiensis n. sp.
Figs. 37N, 54C–D, 55, 56

Type Locality

Western Australia, southwest Kimberley coast, Buccaneer Archipelago, King Sound,

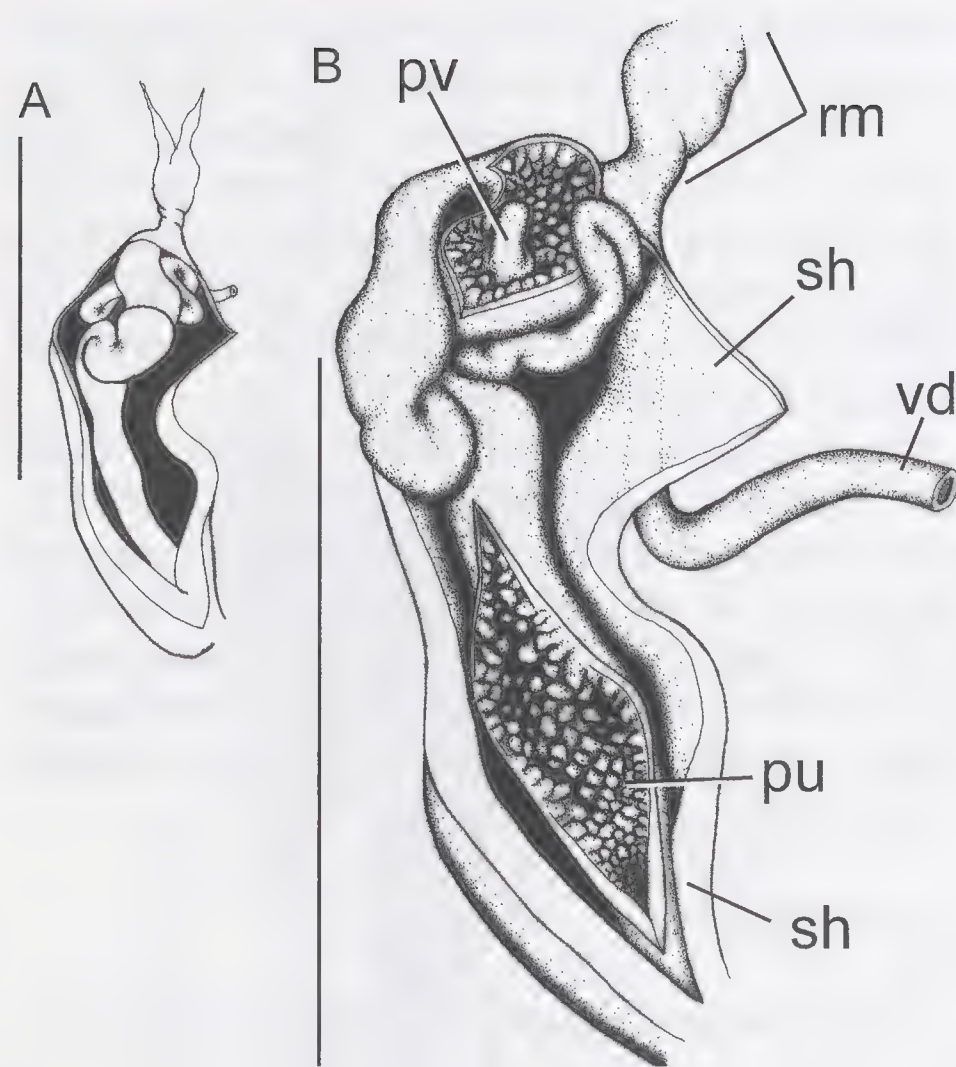


FIG. 53. Penial anatomy of *Kimboraga wulalam* n. sp. paratype AM C471728 (Wulalam Island, May). A: Schematic overview showing penis coiled in penial sheath; B: Detail showing interior of penial wall at distal and proximal end of penis. Scale bars = 10 mm.

Lachlan Island, 16°37'20.6"S, 123°28'15.7"E; coll. Frank Köhler, 25/05/2009, KIS 1–71 (E-facing base of sandstone cliffs, under rocks).

Material Examined

Holotype WAM S58439 (preserved specimen; Fig. 37N, Table 3). Paratypes WAM S37730 (2 preserved specimens, dissected), WAM S37821 (3 shells) from type locality; WAM S37792 (preserved specimen), WAM S37822 (2 shells) from 16°37'20.7"S, 123°28'05.6"E; WAM S37820 (3 shells) from 16°37'22.8"S, 123°28'06.4"E; WAM S49241 (8 preserved specimens) from 16°37'01.3"S, 123°29'21.6"E; WAM S49242 (8 preserved specimens) from 16°36'59.9"S, 123°28'35.1"E; WAM S49243 (13 preserved specimens), AM C471731 (5 preserved specimens) from 16°37'00.9"S, 123°28'18.4"E.

Additional non-type material WAM S49240 (5 preserved specimens) from unnamed island N of Lachlan Is., 16°36'10"S, 123°29'18"E.

Etymology

For Cascade Bay; adjective of feminine gender.

Description

Shell (Figs. 37N, 54A, B): Medium sized ($D = 19\text{--}24$ mm, Table 3), robust, conical with moderately elevated spire. Umbilicus almost completely concealed. Protoconch with very subtle radial growth lines. Teleoconch with well-developed, narrowly arranged radial growth lines, triangular in cross-section, evenly distributed across shell surface. Last whorl wide in cross-section, moderately inflated, with well-rounded periphery, not depressed underneath well-incised suture. Shell colour blends from lighter yellowish brown at tip to dark reddish brown on last whorl, base of shell brownish to yellowish horn, with glossy surface. Aperture wide, inside whitish, with simple, conspicuously expanded lip, palatal or distal nodules absent, parietal wall inconspicuous.

Radula (Fig. 54C–D): $C + 10 + 4 + 14$.

Genital anatomy (Figs. 55–56): Penis moderate in size, coiled within penial sheath, longer

than vagina; penial retractor muscle short. Vas deferens comparatively thick, entering sheath near apex of penial complex. Inner penial wall entirely covered by densely arranged, rhomboid, large pustules, with longitudinal pilasters at distal end of inner penial. Vagina moderately long. Bursa copulatrix short, reaching base of spermoviduct.

Comparative Remarks

Shells from type locality, Lachlan Island, are smaller than those from an unnamed island north of it ($D = 19.2\text{--}22.0$ mm vs. $22.6\text{--}24$ mm) but have similar proportions. Both are considered conspecific for close similarity. Shell is similar to *K. wulalam* but has a more conspicuously expanded lip. Genitalia differ from *K. exanima* and *K. wulalam* most conspicuously by larger and thicker penis with much denser pustulation, pustules larger. Inner penial wall pustulation similar to *K. yampiensis* Solem,

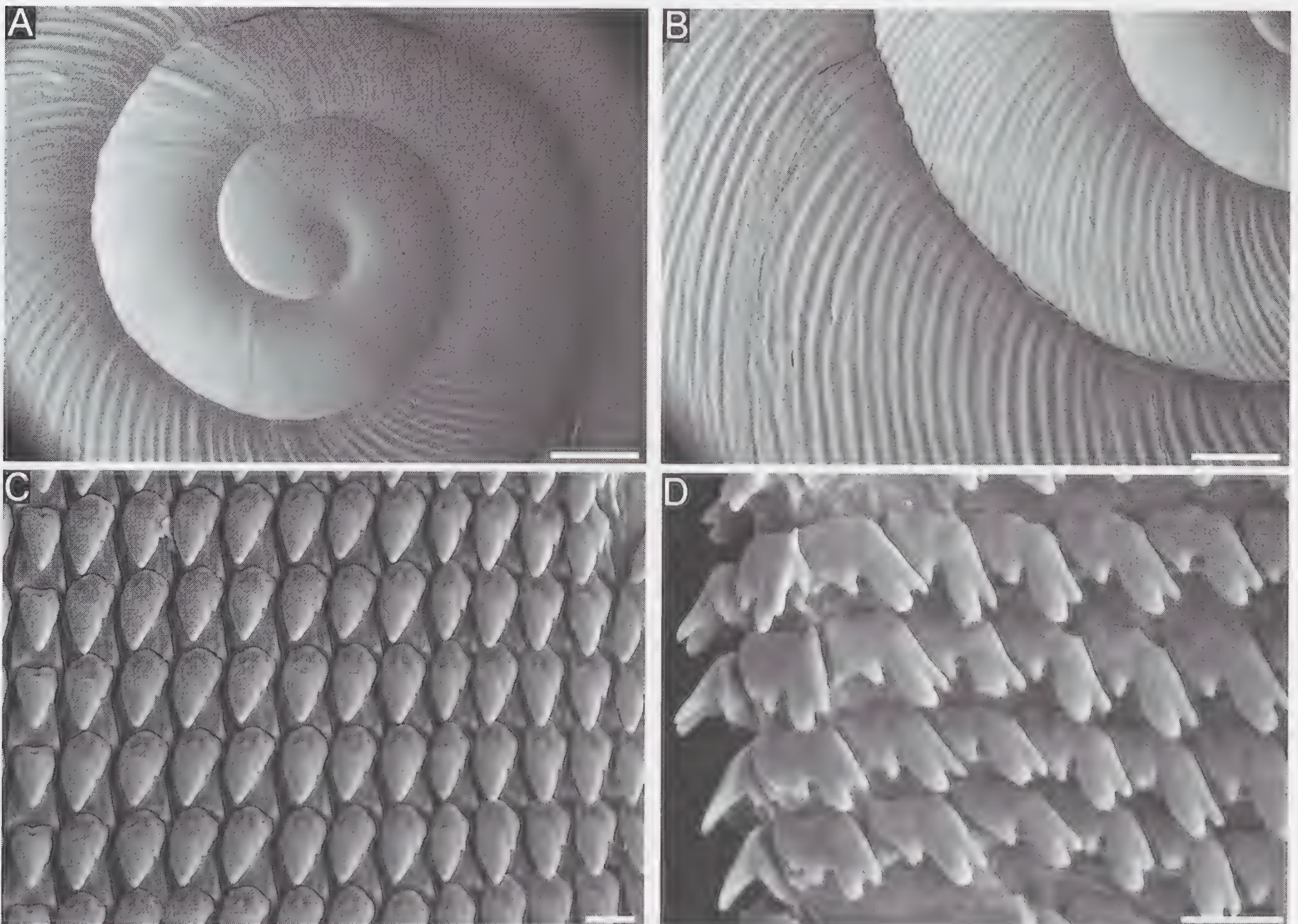


FIG. 54. SEM micrographs of *Kimboraga cascadiensis* n. sp. paratype WAM S37730 (Lachlan Island). A–B: Shell. A: Apical view; B: Sculpture on first and second whorl. Scale bars = 1 mm; C–D: Radula. C: Central and inner lateral teeth viewed from above; D: Close-up of inner to middle marginal teeth. Scale bars = 100 μm .

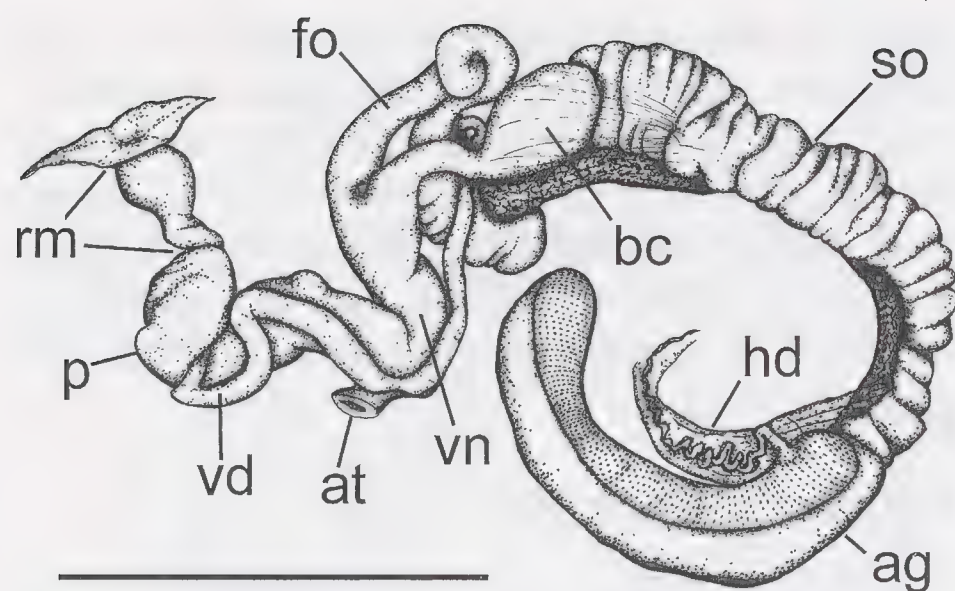


FIG. 55. Genital anatomy of *Kimboraga cascadiensis* n. sp. paratype WAM S49242 (Lachlan Island, February). Scale bar = 10 mm.

1985, and *K. mccorrii* Solem, 1985. However, in *K. yampiensis* pustules are much smaller except for those that form a main pilaster; in both species longitudinal pilasters comprise distal half of inner penial wall, being much longer than in *K. cascadiensis*.

Distribution (Fig. 46)

Lachlan Island and an unnamed island N of Lachlan Island, Cascade Bay, King Sound.

Xanthomelon Martens, 1860

Xanthomelon Martens, 1860 [in Martens & Albers]: 174; Solem, 1979: 9–45 (partim); 1985a: 920–922 (partim); 1991: 175–178 (partim); Solem & McKenzie, 1991: 247–263 (partim). Type species: *Helix pomum* Pfeiffer, 1842 (= *Helyx durvillii* Hombron & Jacquinot, 1841), by original designation.

Taxonomic Remarks

The taxonomy of *Xanthomelon* is complicated. The generic name was introduced for the nominal species-taxon *Helix pomum* Pfeiffer, 1842, for its peculiarly globose, yellowish shell. The type locality was originally given as “Nova Seelandia?” but later corrected to “Port Essington in Neu-Holland” [Port Essington, Coburg Peninsula, 11°12’S, 132°09’E].

Solem (1979) considered *H. pomum* to be a junior synonym of *Helyx durvillii* Hombron & Jacquinot, 1841, from “Raffles Bay, Australia” [Raffles Bay, Coburg Peninsula, 11°12’S, 132°24’E]. Both type localities are indeed in very close proximity in the northeastern part of the Coburg Peninsula, Northern Territory.

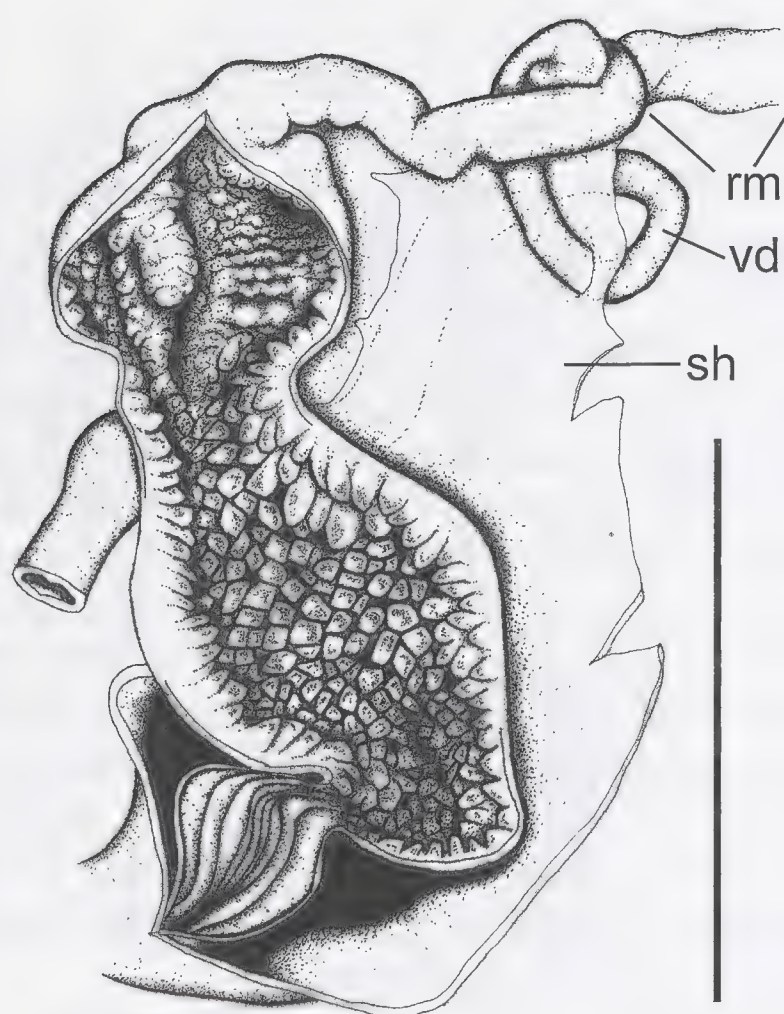


FIG. 56. Penial anatomy of *Kimboraga cascadiensis* n. sp. paratype WAM S49242 (Lachlan Island, February). Scale bar = 5 mm.

Therefore, the suggested treatment of both nominal taxa as synonymous appears to be a plausible taxonomic solution given that currently there is no indication that Coburg Peninsula is inhabited by more than one species of *Xanthomelon*. Solem (1979) provided a comprehensive synonymy of *Xanthomelon durvillii*.

Based on a similar shell, Solem (1979) considered *Helix (Hadra) prudhoensis* E. A. Smith, 1894, to be congeneric. Because *H. prudhoensis* is the type species of *Globorhagada* Iredale, 1939, this genus-group taxon has since been treated as a junior synonym of *Xanthomelon*. Solem (1979) stressed that the name *Globorhagada* was arbitrarily employed to contain species with rounded shells, most of which belong to a number of different genera. However, a mitochondrial phylogeny of the Western Australian Camaenidae indicates that *H. prudhoensis* represents a monophyletic clade distinct from *Xanthomelon* (Köhler, 2009, 2010c). Therefore, the name *Globorhagada* is here removed from the synonymy of *Xanthomelon* and treated as a valid genus. Conversely, the genus *Xanthomelon* is restricted to species that are closely related to the type species *X. durvillii*, such as *X. obliquirugosa*. Stanisic et al. (2010) stated that *Xanthomelon* might be polyphyletic as based on microsculptures.

TABLE 4. Shell parameters of *Xanthomelon* and *Globorhagada*. Given are maximum – minimum (mean ± standard deviation) of shells for N measured specimens. Abbreviations used: HT = holotype.

Species	N	Height (H)	Diameter (D)	Height of Last Whorl (LW)	Umbilicus (U)	No. of Whorls	H/D Ratio
<i>X. obliquirugosa</i>	20	18.0–25.9 (22.4 ± 1.8)	20.3–27.8 (24.2 ± 1.9)	13.4–18.1 (15.6 ± 1.3)	chink - 2.7	3.7–4.5 (4.3 ± 0.2)	0.84–1.02 (0.93 ± 0.04)
<i>G. prudhoensis</i>	14	28.8–35.1 (30.4 ± 1.5)	26.6–31.0 (29.1 ± 1.2)	19.2–21.0 (20.0 ± 0.5)	chink - 4.0	4.0–4.7 (4.2 ± 0.2)	0.93–1.16 (1.05 ± 0.06)
<i>G. confusa</i> n. sp.	HT	35.9	33.6	23.7	chink	4.6	1.07
	3	32.5–37.0 (35.1 ± 1.9)	31.6–34.8 (33.3 ± 1.3)	21.0–23.7 (22.3 ± 1.1)	chink - narrow	4.5–4.8 (5.1 ± 0.1)	0.93–1.17 (1.06 ± 0.10)
<i>G. wurroolgu</i> n. sp.	HT	26.5	28.8	20.6	chink	3.7	0.92
	8	25.3–29.0 (27.1 ± 1.0)	25.7–29.0 (27.3 ± 1.2)	17.8–20.6 (19.0 ± 0.9)	chink - narrow	3.7–4.5 (4.7 ± 0.2)	0.92–1.05 (0.99 ± 0.04)
<i>G. yoowadan</i> n. sp.	HT	31.5	30	21	chink	4.2	1.05
	8	27.4–35.5 (30.5 ± 2.5)	27.3–30.7 (28.9 ± 1.2)	18.3–22.6 (20.0 ± 1.4)	chink - narrow	4.1–4.5 (4.8 ± 0.1)	0.99–1.18 (1.05 ± 0.06)
<i>G. wunandarra</i> n. sp.	11	23.5–25.6 (24.5 ± 0.7)	20.6–22.3 (21.6 ± 0.5)	14.6–16.3 (15.4 ± 0.5)	chink - narrow	4.3–4.5 (4.8 ± 0.1)	1.06–1.18 (1.13 ± 0.03)
<i>G. uwinsensis</i> n. sp.	9	16.4–22.5 (19.7 ± 1.7)	16.1–20.0 (18.3 ± 1.2)	10.5–14.0 (12.6 ± 1.0)	narrow	4.0–4.3 (4.6 ± 0.1)	1.02–1.15 (1.08 ± 0.04)

Diagnosis

Shell: Large to very large (D >20 mm; Table 4), moderately thick, globose, strongly elevated with H/D ratio averaging 1.0; umbilicus narrowly open, partly concealed; protoconch with smooth or faintly pustulose sculpture; teleoconch with variable sculpture, with oblique (microscopic) radial corrugations; body whorl strongly enlarged, descending slightly but abruptly behind apertural lip; whorls rapidly increasing, separated by shallow suture; periphery well rounded to slightly depressed; aperture wide, columellar margin and parietal wall weakly to strongly callued. Shell colour more or less uniform, yellowish brown, no colour banding.

Genital anatomy: Penis with well-developed sheath, extending entire length, thick proximally, thin distally; penis coiled within sheath, inner penial wall entirely covered by pustulation (can be very fine); epiphallus lacking; penial retractor muscle attached to junction with vas deferens. Vas deferens entering penial sheath distally through simple vergic ring (pore). Bursa copulatrix simple, with globular head, reaching or extending base of spermoviduct.

Aestivation Strategy

Free sealer.

Comparative Remarks

A large number of nominal species taxa with uncertain systematic status were subsumed under the generic name *Xanthomelon*. These species have in common the conspicuous shell shape and size being generally considered as characteristic. As the systematic status of many nominal taxa remains uncertain, the comparison between *Xanthomelon* and *Globorhagada* is based on the four species described by Solem (1979): *X. durvillii*, *X. obliquirugosa*, *Globorhagada prudhoensis* and *G. ruberpumilio*. The shell of *Globorhagada* differs subtly by presence of an axial microsculpture of growth lines and/or rows of tiny pustules instead of oblique radial corrugations. *Xanthomelon durvillii* and *X. obliquirugosa* have a more globose shell with less elevated spire than *G. prudhoensis*. However, the shell of *G. ruberpumilio* is of the globose type known from *Xanthomelon*. The different structure of

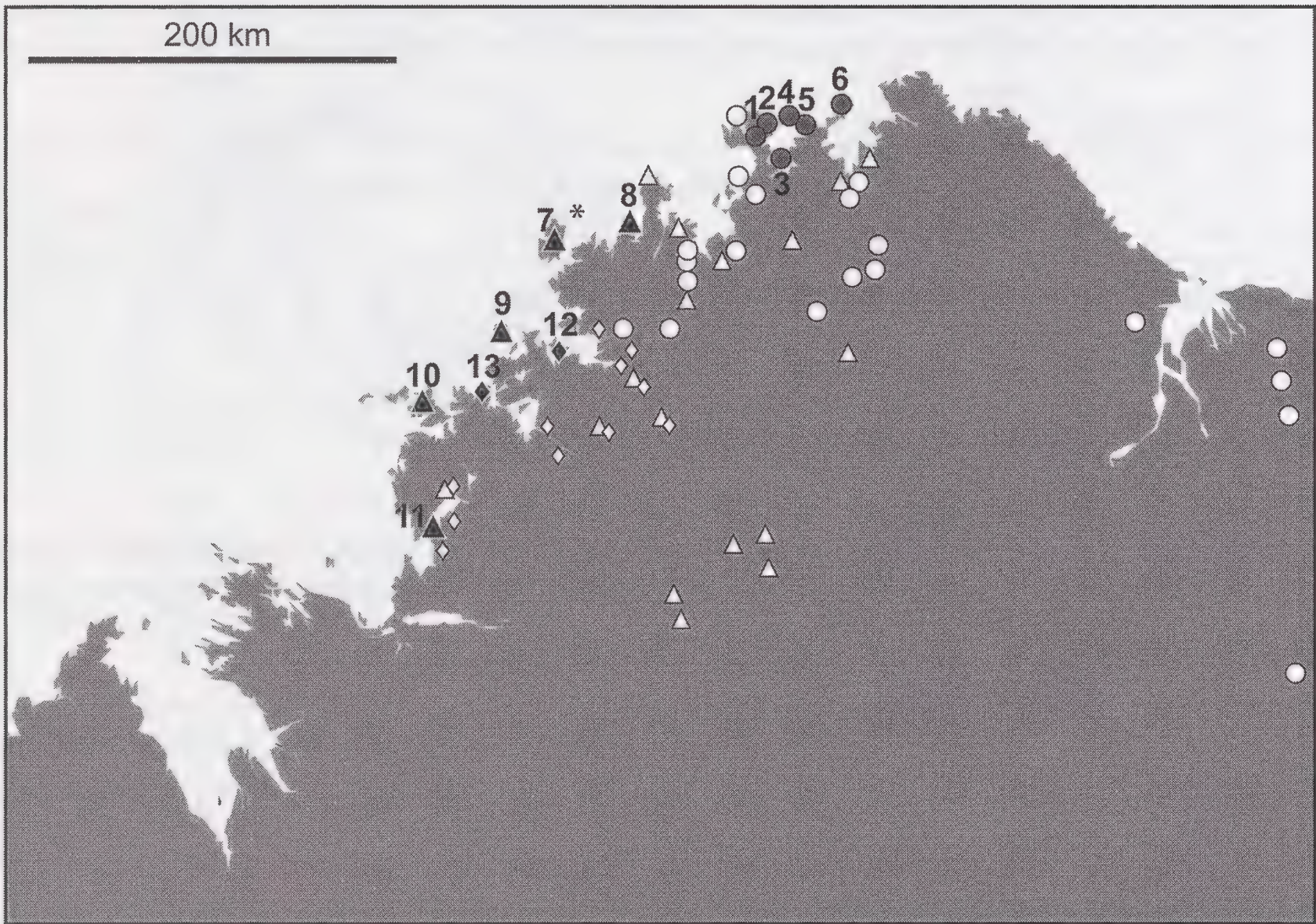


FIG. 57. Distribution map of *Xanthomelon* and *Globorhagada*. *Xanthomelon obliquirugosa*. Full circles = records treated herein: 1: Bougainville Peninsula, 2: Wargul Wargul Island, 3: Low and Jar Islands, 4: Long Island, 5: Mary Island, 6: Sir Graham Moore Island; white circles = records listed by Solem (1991). *Globorhagada prudhoensis* species complex: * = type locality of *G. prudhoensis* (Prudhoe Island); full triangles = records treated herein: 7: *Globorhagada prudhoensis* (Bigge Island), 8: *Globorhagada confusa* n. sp. (Katers Island), 9: *Globorhagada* sp. (Coronation Island), 10: *Globorhagada wurroolgu* n. sp. (Augustus Island), 11: *Globorhagada yoowadan* n. sp. (Storr Island); white triangles = records of *G. prudhoensis* listed by Solem (1991). *Globorhagada ruberpumilio* species complex: full diamonds = records treated herein: 12: *Globorhagada wunandarra* n. sp. (Boongaree Island), 13: *Globorhagada uwinsensis* n. sp. (Uwins Island); white diamonds = records of *G. ruberpumilio* listed by Solem (1991).

inner penial wall is a distinguishing character. In *Xanthomelon* penial wall pustules are present, from well developed to extremely fine, while in *Globorhagada* the wall lacks pustules, being smooth or supporting oblique lateral lamellae.

Distribution (Fig. 57)

Xanthomelon occurs in an area that reaches from the northern Kimberley (Prince Regent Reserve, Drysdale, Kalumburu) probably through to tropical Queensland. Stanisic et al. (2010) remarked that *Xanthomelon* might be polyphyletic. Accordingly, the range in Queensland remains uncertain in absence of a modern revision.

Xanthomelon obliquirugosa
(E. A. Smith, 1894)
Figs. 58A, 49–61

Helix (Hadra) obliquirugosa E. A. Smith, 1894: 90, pl. VII, fig. 17 (“Parry Harbour, northwestern Australia”).
Globorhagada obliquirugosa – Iredale, 1938: 114; 1939: 73, pl. 5, fig. 21.
Xanthomelon obliquirugosa – Solem, 1979: 35–42, pl. 1a, figs. 2a, b, 10a, b, 11a–d; 1985a: 921–922.

Type Locality

Northwestern Kimberley, Bougainville Peninsula, Parry Harbour, Vansittart Bay.

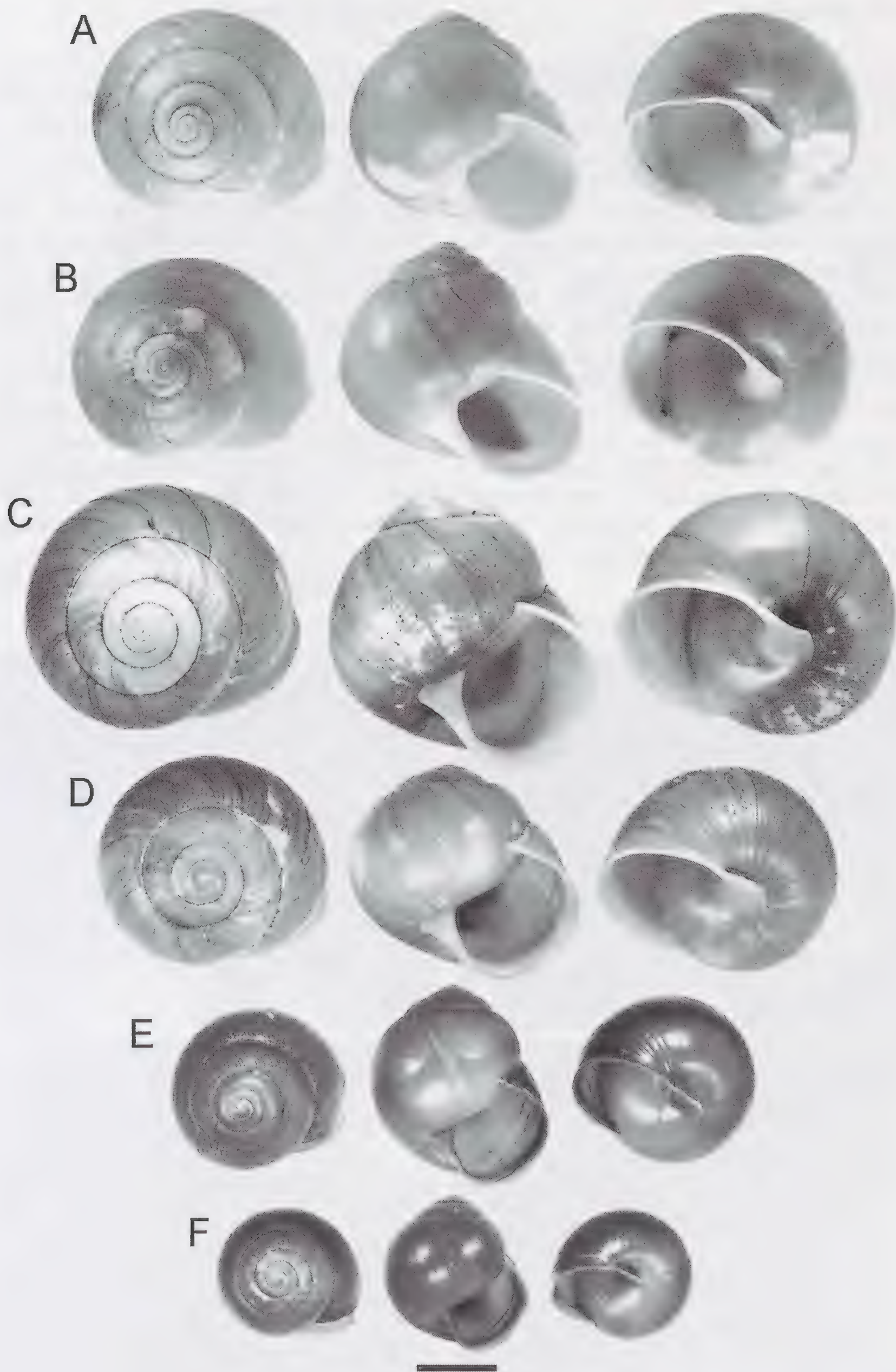


FIG. 58. Shells of *Xanthomelon* and *Globorhagada*. A: *Xanthomelon obliquirugosa* WAM S36532 (Sir Graham Moore Island); B: *Globorhagada prudhoensis* WAM S36507 (Bigge Island); C: ***Globorhagada confusa*** n. sp. holotype WAM S58483 (Katers Island); D: ***Globorhagada wurroolgu*** n. sp. holotype WAM S37631 (Augustus Island); E: ***Globorhagada wunandarra*** n. sp. paratype WAM S37624 (Boongaree Island); F: ***Globorhagada uwinsensis*** n. sp. paratype WAM S36994 (Uwins Island). Scale bar = 10 mm.

Taxonomic Remarks

The name *H. obliquirugosa* was introduced for dry shell material from Parry Harbour, Bougainville Peninsula, NW Kimberley (~ 14°00'S, 126°00'E). The lectotype BMNH 1892.1.29.159 was designated by Solem (1979). Subsequently, he described the anatomy based on specimens from various localities like Mitchell Plateau, Kalumburu and Drysdale River Reserve; none of these being very close to the type locality. Although Solem (1979) noticed considerable geographic variation with regard to shell size, he concluded that *X. obliquirugosa* is widespread ranging from the Prince Regent Reserve in the southwest to the Ningbing Ranges in the northeast. This assumption requires confirmation by future comparative studies, including molecular analyses. Here, for the first time anatomy of topotypic material is examined.

Material Examined

Non-type material AM C471735, WAM S36644–6, WAM 36849, WAM S58440 (9 preserved specimens), AM C471733–4, WAM S36514–32 (shells) from eastern and western sections of Sir Graham Moore Island, Eclipse Archipelago (13°53'S to 13°54'S, 126°35'E to 126°36'E); WAM S49349 (3 preserved specimens), WAM S49359 (5 preserved specimens), AM C471736, WAM S39330 (shells) from Mary Island in Vansittart Bay, 13°59'01–29"S, 126°22'45–59"E; WAM S49331–4 (shells) from Wargul Wargul Island, Vansittart Bay, 13°56'13.0"S, 126°10'27.5"E; WAM S49335 (shell) from Bougainville Peninsula, 13°55'58"S, 126°08'53"E; WAM S49336 (2 shells) from Low Island, Vansittart Bay, 14°09'52"S, 126°17'24"E; WAM S58440 (preserved specimen), WAM S49337 (6 shells) from Long Island, Eclipse Archipelago, Vansittart Bay, 13°56'04"S,

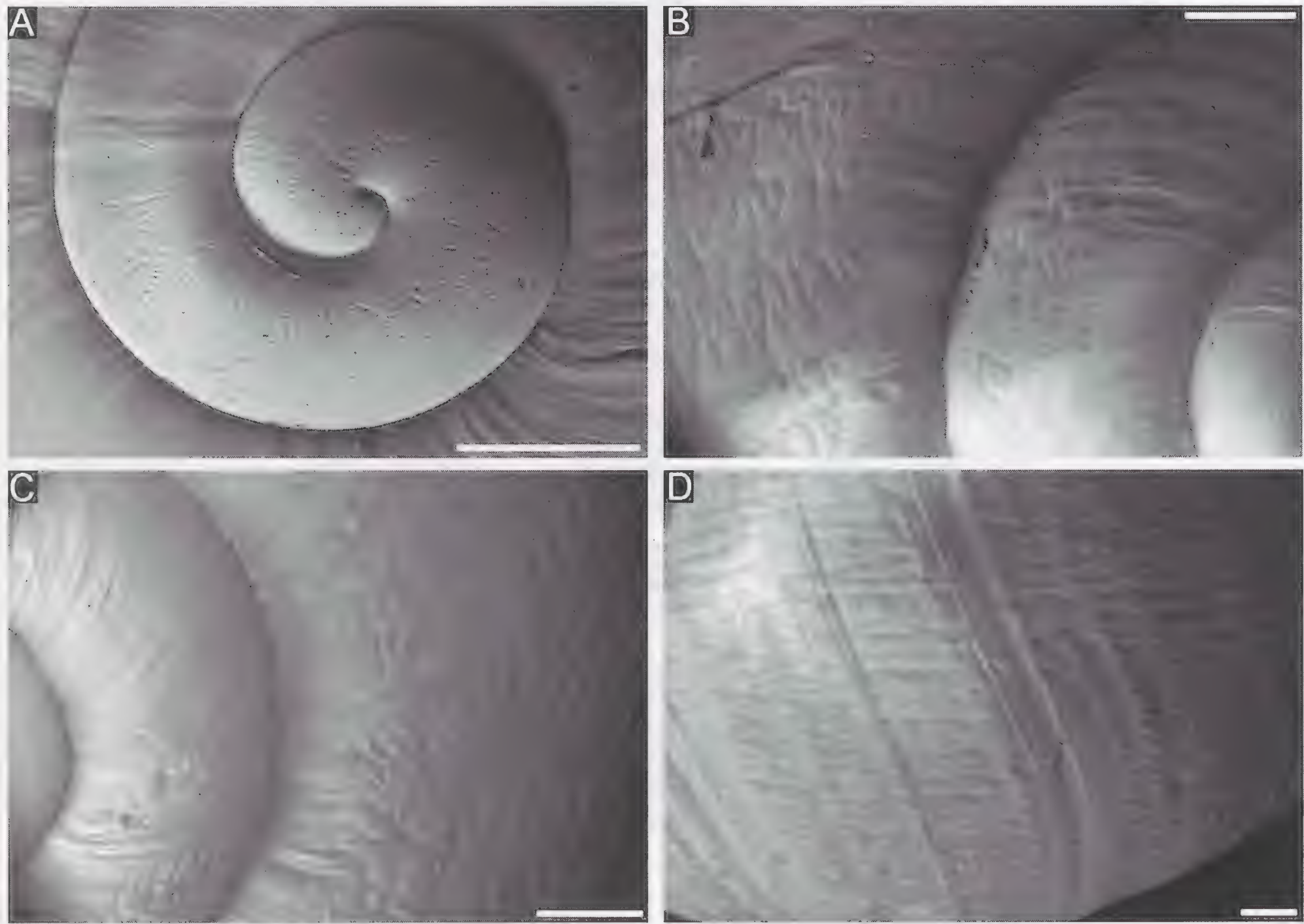


FIG. 59. SEM micrographs of *Xanthomelon obliquirugosa*. A: Apical view showing protoconch (AM C471736, Mary Island); B: Sculpture on first and second whorl (AM C471733, Sir Graham Moore Island); C: Sculpture on first and second whorl (WAM S36521, Sir Graham Moore Island); D: Sculpture on last whorl with typical oblique-radial pustulation (AM C471736, Mary Island). Scale bars = 1 mm.

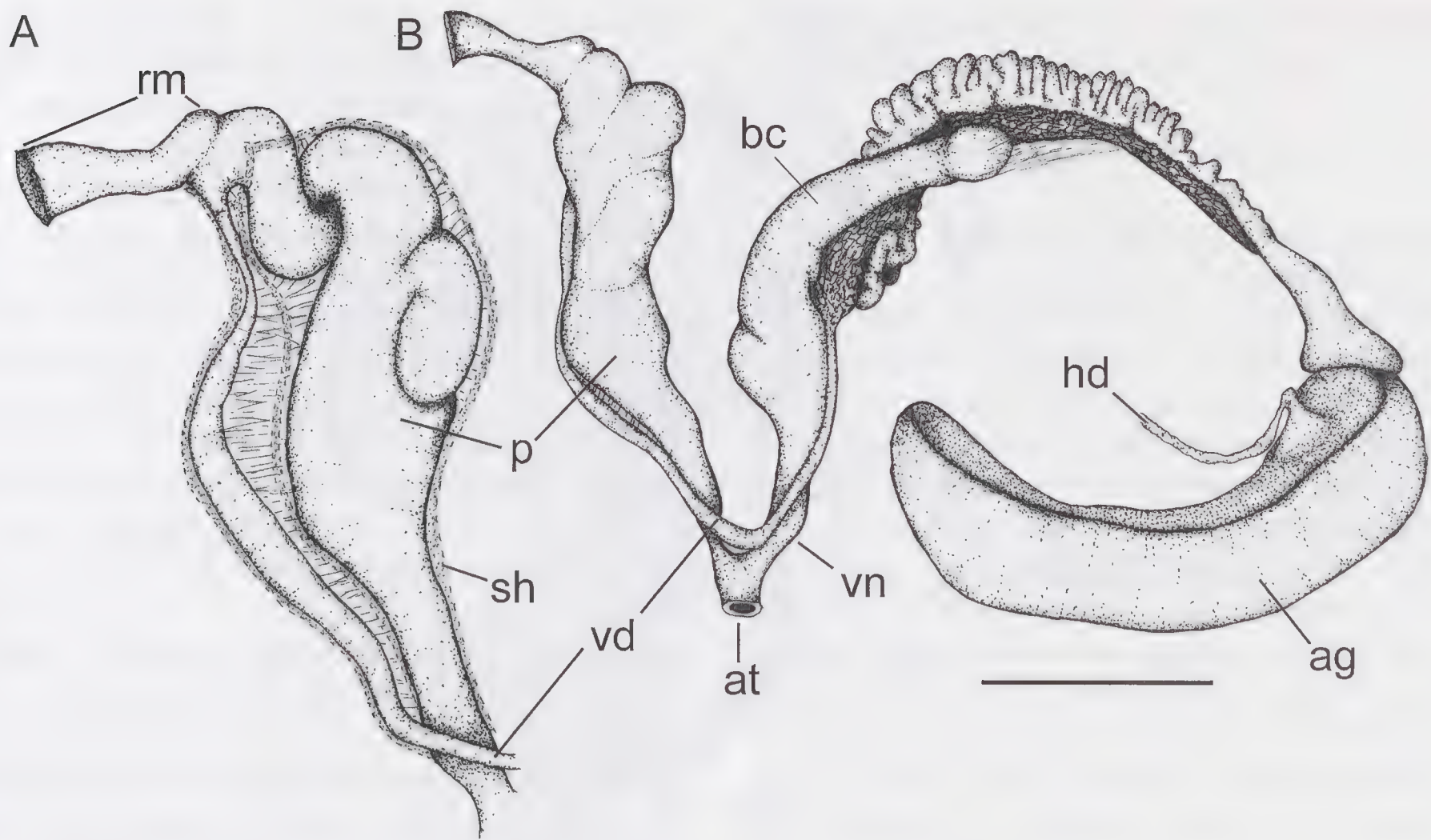


FIG. 60. Genital anatomy of *Xanthomelon obliquirugosa* WAM S36645 (Sir Graham Moore Island, August). A: Enlarged representation of penial complex showing coiling of penis within penial sheath; B: Entire genital system. Scale bar = 5 mm.

126°18'26"E; WAM S49228 (8 shells) from Jar Island, Vansittart Bay, 14°08'59"S, 126°14'10"E.

Diagnosis

Shell: Medium size to large (D = 20–30 mm, H = 18–30 mm), with moderately elevated spire, 3.7–5.0 rapidly increasing whorls; protoconch rather smooth with irregular growth lines; teleoconch with microscopic anastomosing radial rugosities that develop on second whorl continuing onto body whorl towards shell base, plus fine radial growth lines. Lip narrowly to strongly flared, white, sharply reflected, umbilicus forming a chink; colour light yellow-green, parietal callus thin, white (Figs. 58A, 59A–D).

Genital anatomy: Penis long, coiled, with thick glandular walls, inner wall entirely covered with extremely fine, dense pustulation, irregular longitudinal pilasters comprising entire length of wall, stimulatory pilaster lacking (Fig. 60). Vagina moderately long, tubular; bursa copulatrix thick, extending anterior end of spermoviduct with globular head; free oviduct shorter than vagina (Fig. 61) (modified from Solem, 1979).

Mitochondrial Differentiation

Intraspecific genetic divergence: 0.01 (4 sequences); mean p-distance to *X. durvillii* (3 sequences): 0.20.

Comparative Remarks

Compared with Solem's (1979) anatomical description based on material from various localities in the northern Kimberley, topotypic material examined here revealed no strikingly different features. However, more comprehensive studies of patterns of genetic and anatomical differentiation of populations across the entire range are needed for a proper delimitation of species. *Xanthomelon durvillii* differs by much weaker microsculpture of oblique radial corrugations and well-developed pustulation of inner penial wall, which also supports a main stimulatory pilaster. For comparison with species of *Globorhagada* refer to remarks given under the genus.

Distribution

Bougainville Peninsula and islands in Vansittart Bay, northern Kimberley. Reported from northernmost parts of Kimberley mainland between Prince Regent Reserve in the southwest and Ningbing Ranges in the northeast by Solem (1979).

Globorhagada Iredale, 1933

Globorhagada Iredale, 1933: 52; 1938: 114; 1939: 72–73. Type species: *Helix* (*Hadra*)

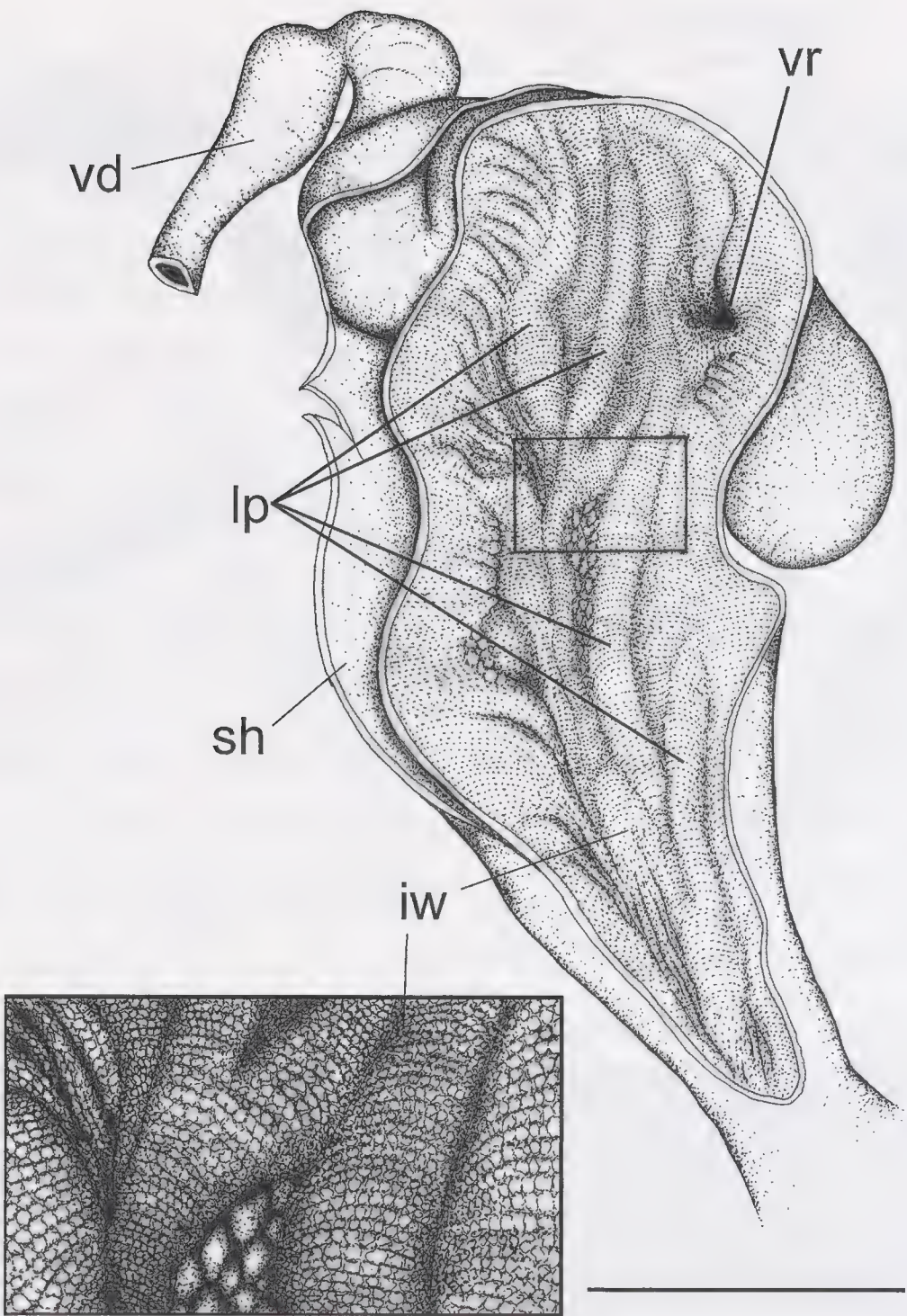


FIG. 61. Penial anatomy of *Xanthomelon obliquirugosa* WAM S36645 (Sir Graham Moore Island, August). Inset: 3-fold magnification of marked area of inner penial wall showing extremely fine pustulation. Scale bar = 3 mm.

prudhoensis E. A. Smith, 1894, by original designation.
Xanthomelon – Solem, 1979: 9–45 (partim); 1985a: 920–922 (partim); 1991: 175–178 (partim); Solem & McKenzie, 1991: 247–263 (partim).

Type Species

Helix (Hadra) prudhoensis E. A. Smith, 1894, by original designation.

Taxonomic Remarks

The name *Globorhagada* was validly introduced as subgenus within *Rhagada* by Iredale (1933), who provided a type species and a brief diagnosis (“large and globose, with open circular mouth, the columellar thickened, much reflected and appressed but not closing the umbilicus, a thick glaze joining the inner and outer lips”). None

of these features are considered to be diagnostic for this genus, however. The taxon has subsequently been treated as a junior synonym of *Xanthomelon* (Solem, 1979). Herein, *Globorhagada* is removed from synonymy of *Xanthomelon* and elevated to the rank of a distinct genus while Iredale’s (1933) description is being completed. Two previously recognised species, *G. prudhoensis* and *G. ruberpumilio* (Solem, 1979), are placed within that genus. Both taxa as delineated so far are considered to represent species complexes according to patterns of anatomical and mitochondrial differentiation unrevealed by comparative studies of material from several localities in the Kimberley.

Diagnosis

Shell: Large to very large (D = 16–36 mm; Table 4), moderately thick, globose, strongly elevated, H/D ratio averaging 1.0; umbilicus

partly concealed; protoconch from rather smooth to sculptured with faint radial growth lines; teleoconch sculpture variable, with axial rows of more or less well-developed pustulation; prominence decreased near sutures; body whorl strongly enlarged, descending slightly but abruptly behind apertural lip; whorls rapidly increasing, separated by shallow suture; periphery well rounded to slightly depressed; aperture wide, columellar margin and parietal wall weakly to strongly callused. Shell colour more or less uniform, yellowish to dark brown, no colour banding.

Radula: 3.5–5.5 mm long; C + 16–32 + 3–4 + 20–36.

Genital anatomy: Penis with well-developed sheath, extending entire length, thick proximally, thin distally; penis straight or coiled within sheath, inner penial wall lacking well-differentiated main pilaster, usually with oblique lamellae, exceptionally also smooth, but never with pustulation; epiphallus lacking; penial retractor muscle attached to junction with vas deferens. Vas deferens entering penial sheath distally, entering penial chamber through simple pore. Bursa copulatrix simple, with globular head, reaching or extending base of spermoviduct.

Aestivation Strategy

Free sealer.

Comparative Remarks

The shell of *Globorhagada* reveals no apparent feature to distinguish it from *Xanthomelon*. A different microsculpture of the teleoconch (axial rows of tiny pustules instead of oblique corrugations) and distinct armature of the inner penial wall (oblique lamellae instead of pustules), and vas entering penial sheath distally instead of proximally are considered to be the main differentiating features. From all other camaenid taxa, *Globorhagada* is readily distinguished by large, globose, mostly yellowish shell with flaring aperture. Two species have been recognised, *G. prudhoensis* and *G. ruberpumilio*, which are easy to differentiate by distinct shell and penial anatomy. Patterns of anatomical and mitochondrial differentiation suggest that both taxa represent complexes of anatomically similar species, which are characterised by rather subtle differences in shell and penial anatomy. Interspecific genetic p-distances within each complex (0.04–0.09) are about an order of magnitude larger than infraspecific genetic p-distances (0.002–0.012) and an order of

magnitude smaller than mean genetic distance between species complexes (0.23).

Diversity and Distribution (Fig. 57)

Species of *Globorhagada* occur in most of the Kimberley between the Drysdale River Reserve in the northeast and the Doubtful Bay area in the southwest; mostly at localities within 60 km distance from the coast; distribution in the interior and east Kimberley unclear. Distribution overlaps with *Xanthomelon* in northern Kimberley (Prince Regent, Kalumburu, Drysdale River areas). Herein, four species are recognised within *G. prudhoensis* species complex that occur on Bigge, Katers, Augustus and Storr islands, respectively, including adjacent areas and/or islands. Shell fragments that do not permit species identification were also found on northern section of Coronation Island, 14°58'14–30"S, 124°54'24–31"E (WAM S37385–6). Within the *G. ruberpumilio* complex, two species are newly described from Boongaree and Uwins islands, respectively, in addition to *G. ruberpumilio*. Hence, current number of *Globorhagada* species is seven.

Globorhagada prudhoensis Complex

This complex contains species with similar shells that are characterised by distinct penial wall anatomy and separated by relatively low infraspecific p-distances 16S.

Globorhagada prudhoensis (E. A. Smith, 1894) Figs. 58B, 62–64

Helix (Hadra) prudhoensis E. A. Smith, 1894: 91, pl. VII, fig. 9 ("Prudhoe Island, northwestern Australia").

Globorhagada prudhoensis – Iredale, 1938: 114, Iredale, 1939: 72, pl. 5, fig. 19 (not *Xanthomelon prudhoensis* – Solem, 1979: 35–42, pl. 1a, figs. 2a, b, 10a, b, 11a–d, Solem, 1985a: 921–922).

Type Locality

Northwestern Kimberley, Bonaparte Archipelago, Montague Sound, Prudhoe Island (~ 14°25'10"S, 125°15'48"E).

Taxonomic Remarks

Description based on two leached and worn shells; Solem (1979) designated the lectotype

BMNH 1892.1.29.165. The anatomy was described by Solem (1979) based on specimens from mainland localities, such as Mitchell Plateau, Prince Regent Reserve, and Kalumburu, which exhibited similar features across a large range on the mainland. Furthermore, Solem (1979) assumed that mainland populations were conspecific with the types from Prudhoe Island. However, this study revealed that offshore islands harbour distinct species, which are recognised by different anatomy of the inner penial wall. A distinct species was also found on Bigge Island, which is in close proximity of Prudhoe Island (about 10 km to the west). It is considered more likely that the Bigge Island population is conspecific with the types than the mainland populations from a larger distance studied by Solem (1979). It is therefore concluded that Solem's (1979) description does not refer to the taxon described by Smith (1894) but to a distinct, yet unnamed species. The description of *G. prudhoensis* is

corrected accordingly based on description of material from Bigge Island.

Material Examined

AM C471852, WAM S36636–43, WAM S36760, WAM S36850–5 (preserved specimens), AM C471853, WAM S36443, WAM S36450, WAM S36502–13, WAM S36954–6 (shells) from Bigge Island, 14°35'00"–20'5"S, 125°05'57"–11'24"E.

Description

Shell (Figs. 58B, 62A–C, Table 4): Very large, globose to broadly conical, with well-to strongly elevated spire, body whorl largely expanded with compressed periphery, well rounded below, slightly shouldered above, suture relatively shallow; colour evenly yellowish green, inner lip whitish. Protoconch ~ 4.2 mm in diameter, comprising 1–1.5 whorls, with faint radial lirae

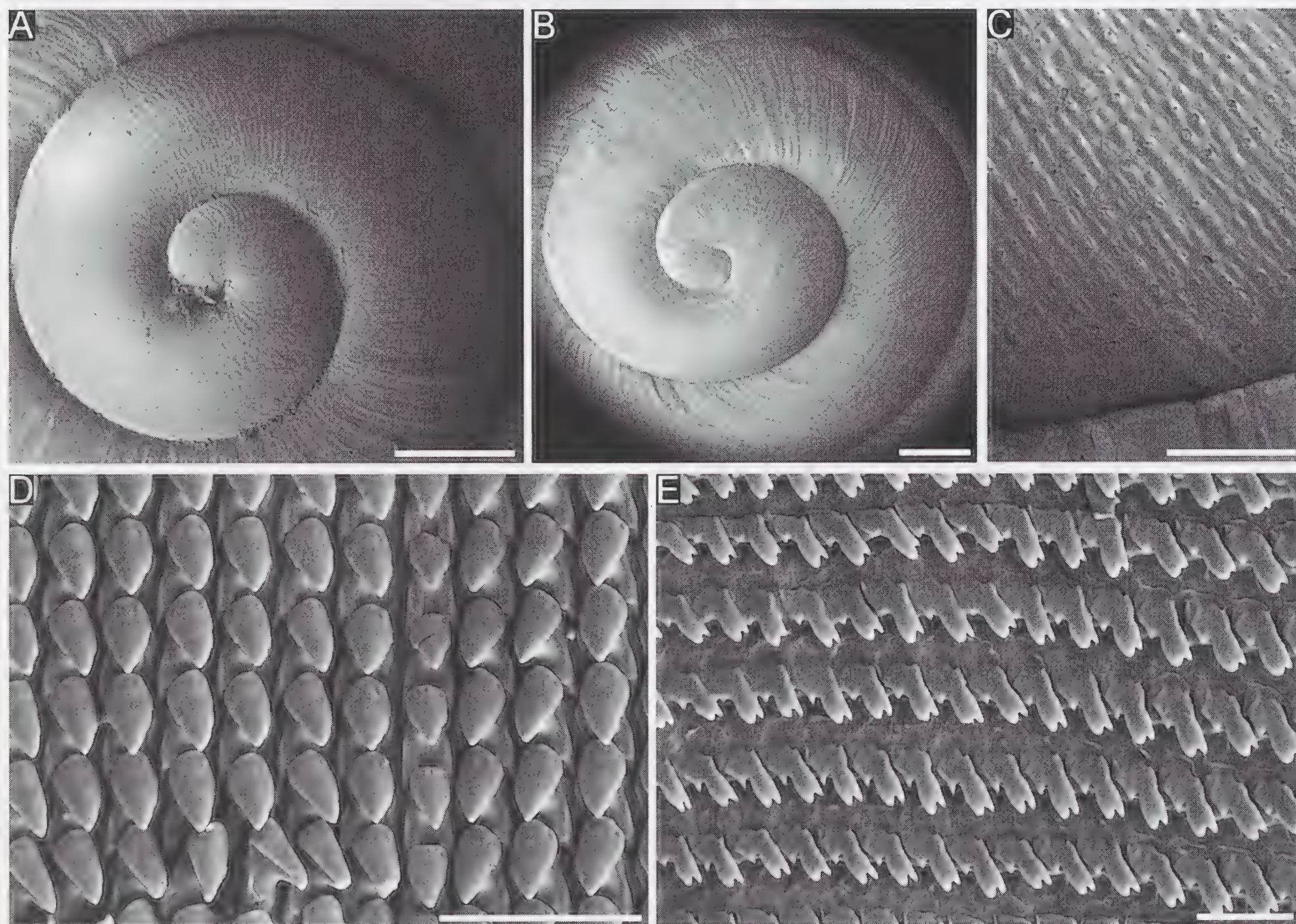


FIG. 62. SEM micrographs of *Globorhagada prudhoensis* (Bigge Island). A–C: Shell. Scale bars = 1 mm. A: Apical view showing protoconch (WAM S36443); B: Apical view showing sculpture on first whorl (AM C471853); C: Detail of sculpture on penultimate whorl with typical axial corrugation (WAM S36510); D–E: Radula (AM C471855); D: Central and inner lateral teeth viewed from above. Scale bar = 100 μ m; E: Close-up of middle and outer marginal teeth. Scale bar = 50 μ m.

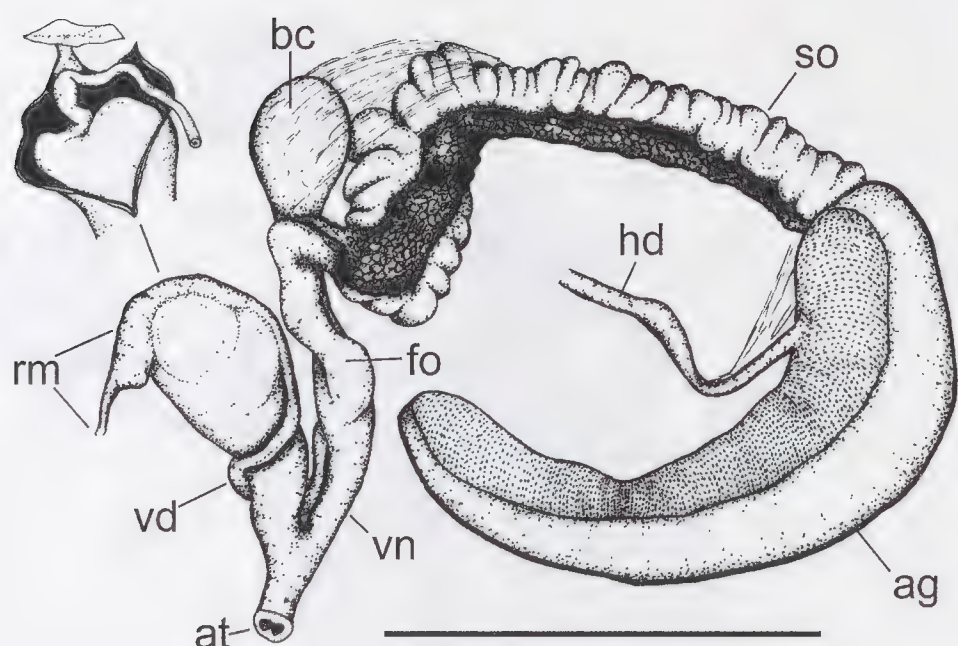


FIG. 63. Genital anatomy of *Globorhagada prudhoeensis* WAM S36641 (Bigge Island, July), inset showing detail of penial apex with penial sheath removed. Scale bar = 10 mm.

only. Teleoconch with regular, faint axial growth lines supporting rows of tiny pustulation, evenly distributed across shell, reduced at base. Umbilicus narrowly open, up to 4 mm wide, partly concealed (0 to 90%). Aperture well rounded, wide, simple, moderately thick, basal node weak to absent, palatal node absent, parietal wall thin, white.

Radula (Fig. 62D–E): 3.5–5.5 mm long; C + 24–32 + 3–4 + 26–36.

Genital anatomy (Figs. 63–64): Penis long, cylindrical, not coiled within penial sheath, with thick glandular walls. Vas entering penis through relatively wide, collar-shaped vergic ring located in apical portion of penial chamber; inner wall with complex patterns of laterally corrugated, crescent-shaped pads that form around a central gutter running longitudinally along inner surface of penial wall, no main stimulatory pilaster. Vagina moderately long, tubular. Bursa copulatrix thick with well-globular head, slightly extending anterior end of spermoviduct.

Mitochondrial Differentiation

Mean infraspecific sequence divergence 0.002 (3 sequences); mean p-distances to other species of the *G. prudhoeensis*-complex between 0.07 and 0.09; mean p-distances to species of the *G. ruberpumilio*-complex 0.23–0.27.

Comparative Remarks

Anatomical description based on dissection of two specimens. The most significant differ-

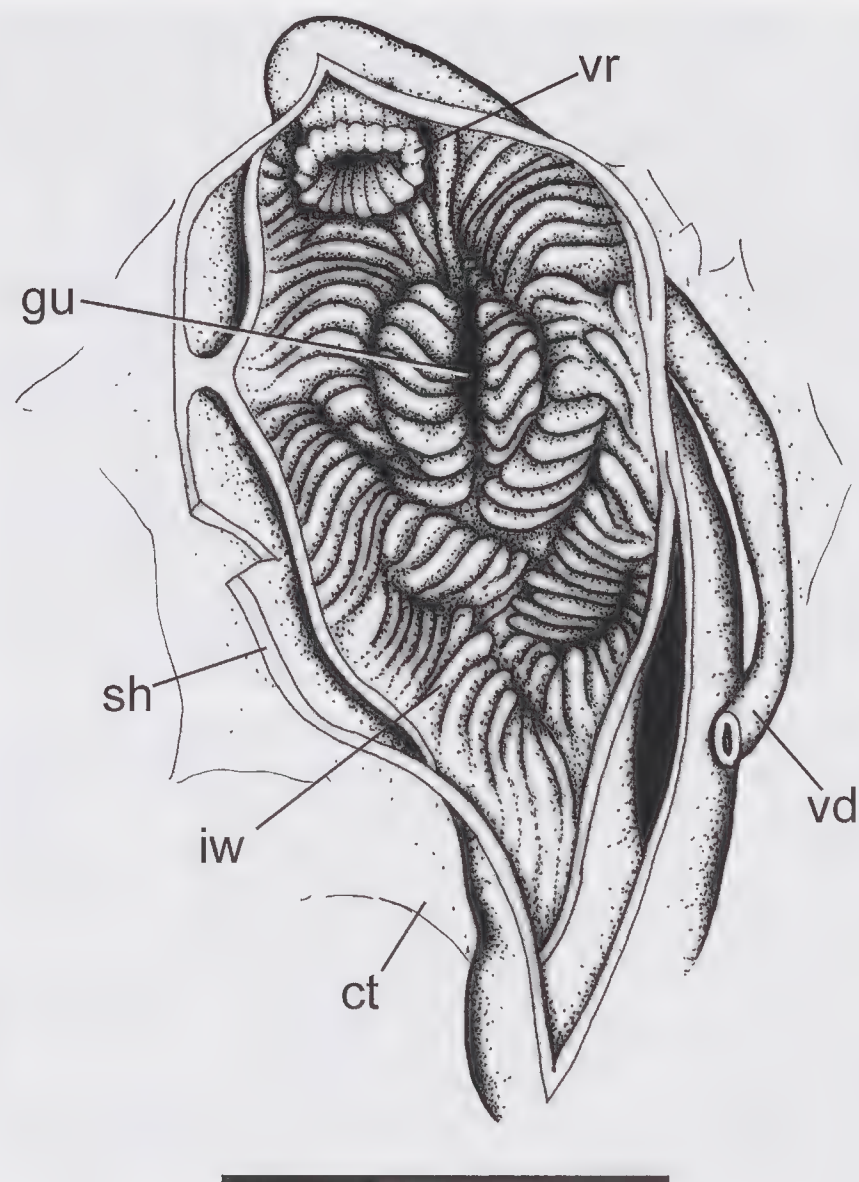


FIG. 64. Penial anatomy of *Globorhagada prudhoeensis* WAM S36641 (Bigge Island, July). Scale bar = 3 mm.

ence compared to Solem's (1979) description of the mainland species is the very distinct inner penial wall sculpture, which is considered to justify recognition of both taxa as distinct species. Species of the *G. prudhoeensis* complex do not vary significantly in their shell with amount of variation within local populations being comparable to that between species.

Distribution (Fig. 57)

Prudhoe and Bigge islands; in contrast to earlier accounts (Solem, 1979, 1991), not known from the Kimberley mainland.

Globorhagada confusa n. sp.

Figs. 58C, 65–67

Xanthomelon prudhoeensis – Solem, 1979: 35–42, pl. 1a, figs. 2a, b, 10a, b, 11a–d; 1985a: 921–922) (not *Helix* (*Hadra*) *prudhoeensis* E. A. Smith, 1894).

Type Locality

Western Australia, northwestern Kimberley, Bonaparte Archipelago, Montage Sound, W coast of Katers Island, 14°26'56.5"S,

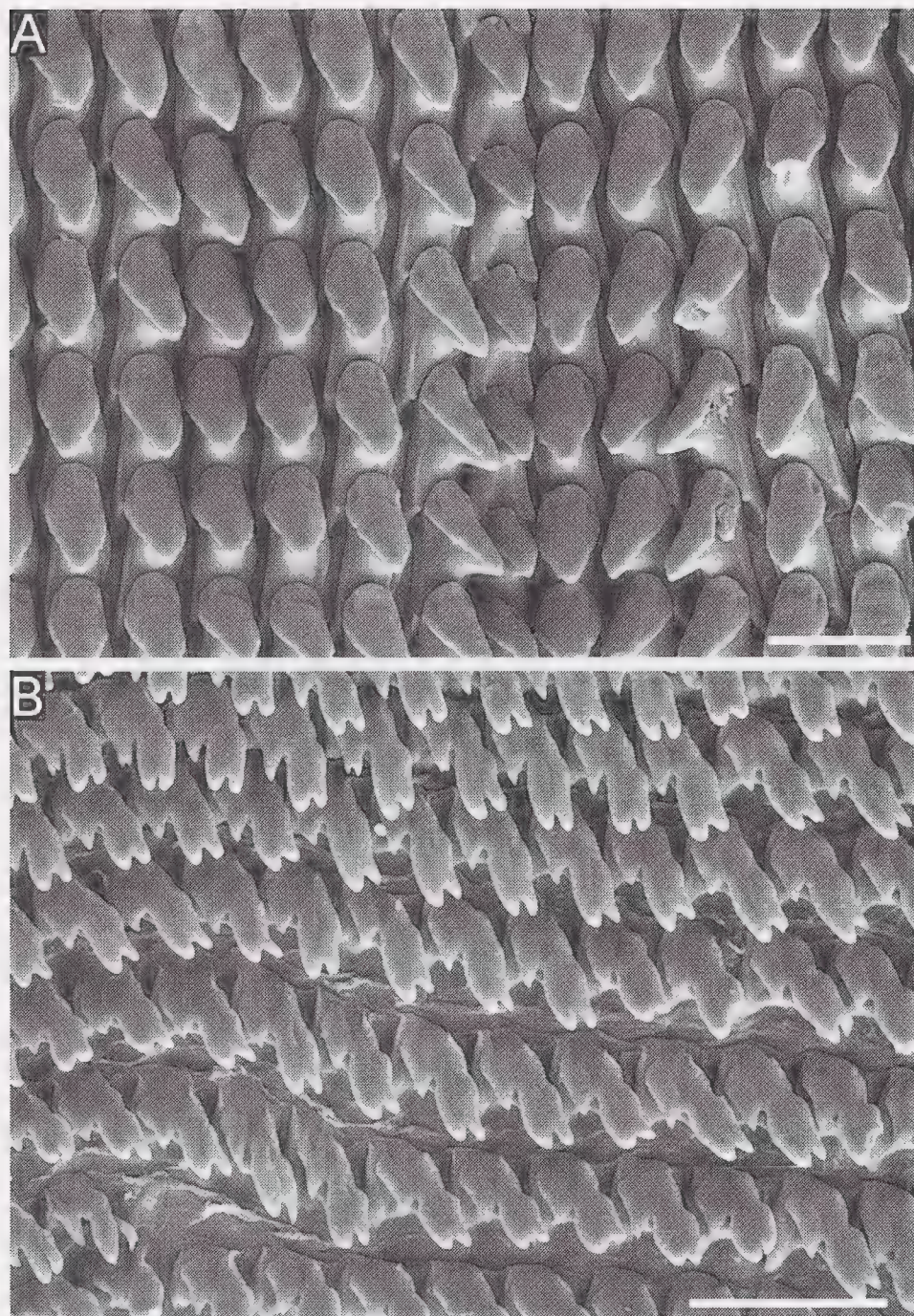


FIG. 65. SEM micrographs of the radula of *Globorhagada confusa* n. sp. paratype WAM S36856 (Katers Island). A: Central and inner lateral teeth viewed from above; B: Marginal teeth viewed from above. Scale bars = 50 μ m.

125°31'22.7"E; coll. Paul Doughty, 14/02/2008, KIS 2–36 (in caves and near ledges on sandstone; active on ground at night after rain).

Taxonomic Remarks

When Solem (1979, 1991) described the anatomy of the present species as based on specimens from around Kalumburu Mission, he assumed it was identical with the taxon from Prudhoe Island named "*H. prudhoensis*" by Smith (1894). Here, evidence is presented that Solem's (1979) description refers to a distinct species and that the name "*prudhoensis*" was incorrectly applied. Because no other name is available, the new species *G. confusa* is herein described for material from Katers Island. The anatomy of specimens from Katers Island fit well Solem's anatomical description of material from Kalumburu. Material from both localities is thus considered conspecific. Solem's (1979) description of "*Xanthomelon prudhoensis*" as

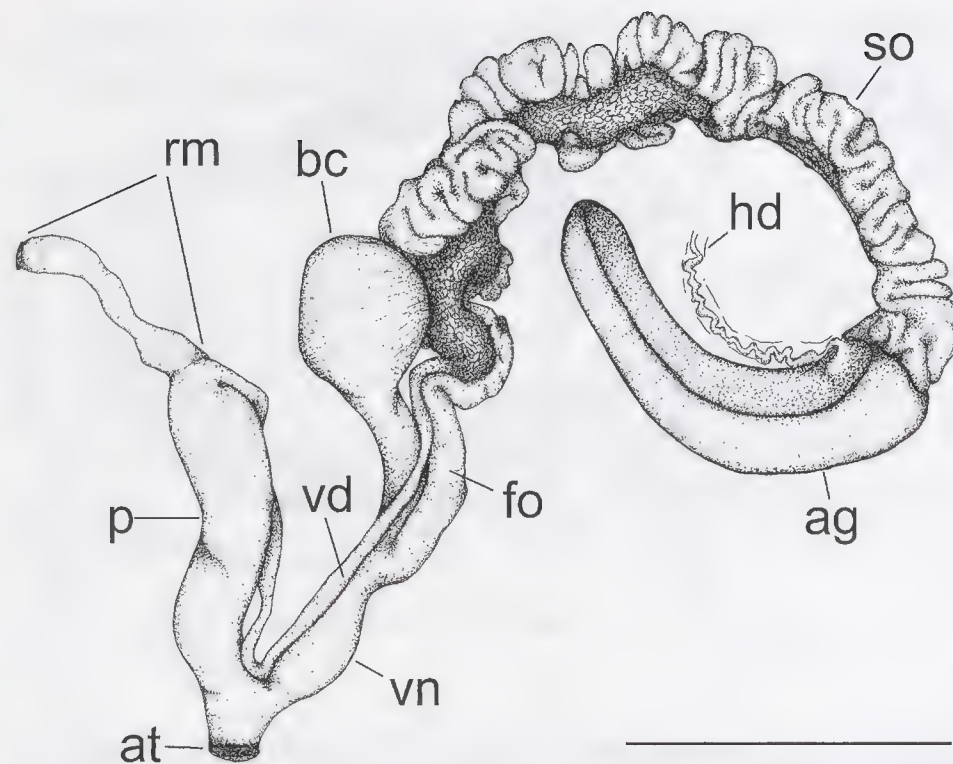


FIG. 66. Genital anatomy of *Globorhagada confusa* n. sp. paratype WAM S36856 (Katers Island, February). Scale bar = 10 mm.

well as the notion of a wide mainland distribution of this species in the Kimberley refers to the present species.

Material Examined

Holotype WAM S58483 (preserved specimen, Fig. 58C). Paratypes AM C471857 (preserved specimen, dissected), WAM S36856 (preserved specimen), WAM S36451 (juvenile shell), WAM S36966 (worn shell), WAM S36973 (worn shell) from west coast of Katers Island, 14°26'45.6" to 14°26'59.4"S, 125°30'53.9" to 125°31'22.7"E.

Etymology

The name refers to the confusion of this species with *G. prudhoensis* by Solem (1979).

Description

Shell (Fig. 58C; Table 4): Very large, globose to broadly conical, with well to strongly elevated spire, body whorl largely expanded with compressed periphery, well rounded below, slightly shouldered above, suture shallow; colour evenly yellowish green, inner lip whitish. Protoconch about 4.2 mm in diameter, comprising 1–1.5 whorls, with faint radial lirae only. Teleoconch with regular, faint axial growth lines supporting axial rows of tiny pustulation, evenly distributed across shell, reduced at base. Umbilicus up to 4 mm wide, partly concealed (0 to 90%). Aperture well rounded, wide, simple,

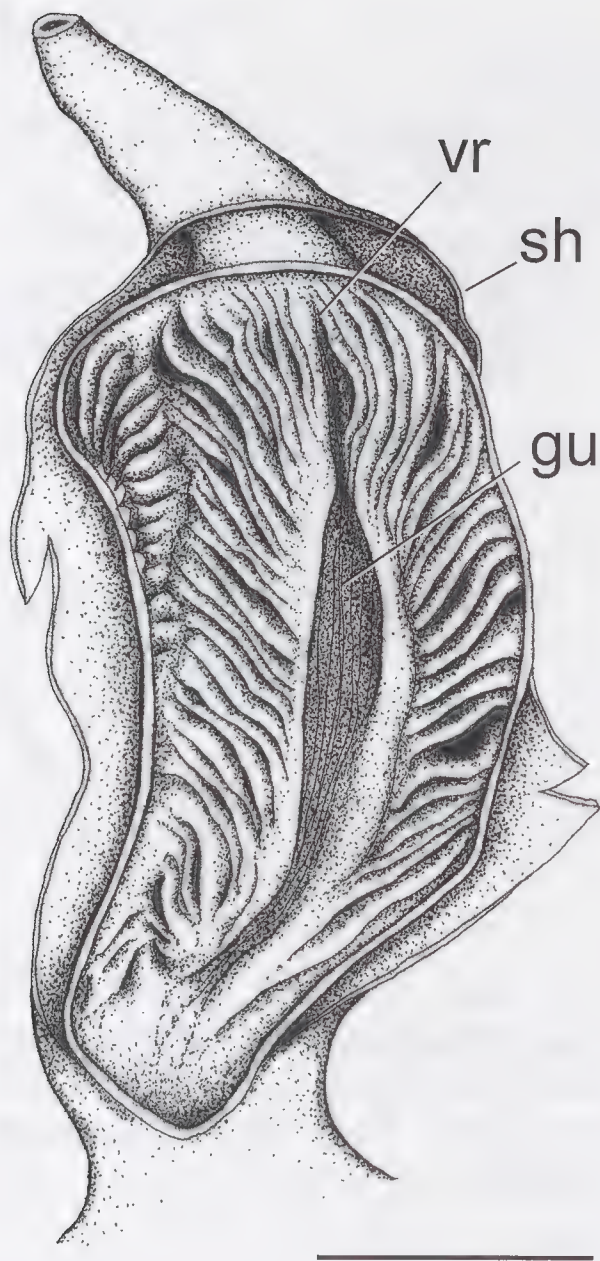


FIG. 67. Penial anatomy of *Globorhagada confusa* n. sp. paratype WAM S36856 (Katers Island, February). Scale bar = 3 mm.

Comparative Remarks

Anatomical description based on dissection of two specimens. Anatomy described here corresponds well with Solem's (1979) description of "*Xanthomelon prudhoensis*" from NW Kimberley mainland, confirming that Katers Island population is conspecific with mainland form (Katers Island being separated from mainland by a narrow strait only). It differs most conspicuously from *G. prudhoensis* by inner penial wall sculpture consisting of obliquely radial lamellae instead of transversely corrugated, crescent-shaped pilasters. In addition, vas deferens enters penial lumen through wide, simple pore instead of collar-like vergic ring. Only three adults available from Katers Island. These differ from *G. prudhoensis* by larger size ($H = 35.1$ mm on average instead of 30.4 mm; Table 4). However, number of measured specimens is too small to allow for statistically significant comparison. Solem (1979) provided measurements of a large number of specimens ranging in height between 24.6 and 35.1 mm.

Distribution (Fig. 57)

According to Solem (1979), fairly widespread on mainland from Drysdale River Reserve in the northeast to Prince Regent Reserve in the southwest, including Kalumburu and Mitchell Plateau, plus Katers Island.

Globorhagada wurroolgu n. sp. Figs. 58D, 68, 69

Type Locality

Western Australia, central Kimberley coast, Bonaparte Archipelago, Camden Sound, north-western section of Augustus Island, $15^{\circ}20'11''S$, $124^{\circ}31'10''E$; coll. Vince Kessner, 13/02/2009, KIS 1–67 (open woodland on moderately steep W-facing slopes at base of sandstone cliffs; active after rain).

Material Examined

Holotype WAM S37631 (preserved specimen, dissected, Fig. 58D). Paratypes AM C471858 (preserved animal) from type locality; WAM S37380 (shell), WAM S37381 (shell), WAM S37382 (shell), WAM S37387 (2 shells), WAM S37388 (shell), WAM S49013 (2 shells) from northwestern section of Augustus Island; WAM S37632 (preserved specimen) from eastern

moderately thick, basal node weak to absent, palatal node absent, parietal wall thin, white.

Radula (Fig. 65): 4.7 mm long with 135 rows of teeth, $C + 24 + 3 - 4 + \sim 30$ ($n = 1$).

Genital anatomy (Figs. 66–67): Penis tubular, not coiled within penial sheath, with thick, glandular walls. Vas entering penial sheath within distal third of penial complex, entering penial chamber through wide, simple pore that gives rise to a sperm gutter running along entire inner penial wall; narrow, obliquely lateral lamellae form on both sides of gutter. Vagina moderately long, tubular. Bursa copulatrix thick, head globular, slightly extending anterior end of spermoviduct.

Mitochondrial Differentiation

Mean infraspecific sequence divergence 0.002 (3 sequences); mean p-distances to other species of the *G. prudhoensis*-complex between 0.04 and 0.09; mean p-distances to species of the *G. ruberpumilio*-complex 0.21–0.24.

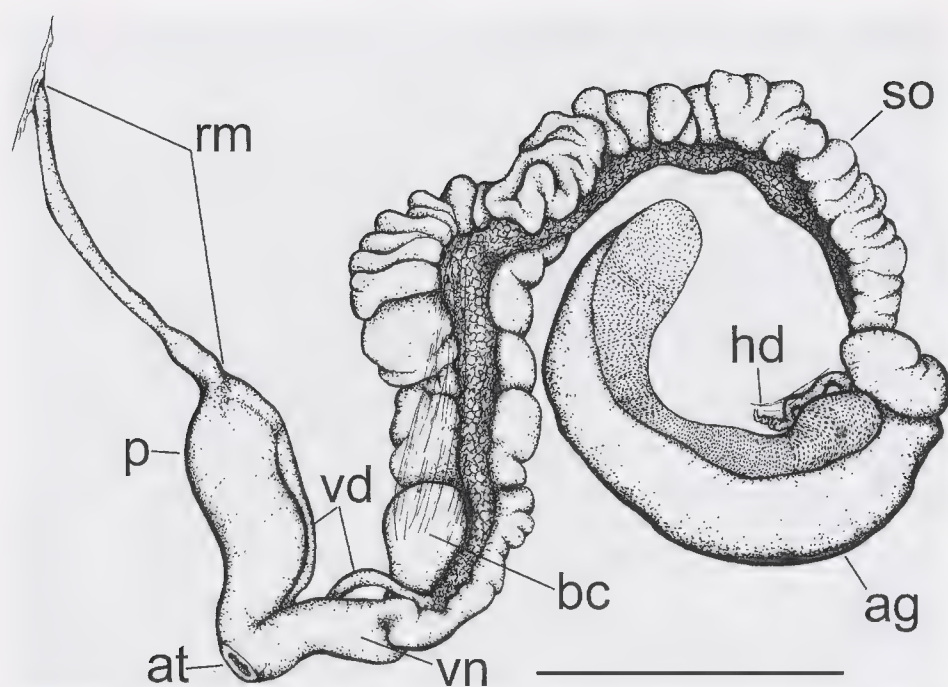


FIG. 68. Genital anatomy of *Globorhagada wurroolgu* n. sp. holotype WAM S37631 (Augustus Island, February). Scale bar = 10 mm.

section of Champagne Island, 15°17'42"S, 124°16'39"E.

Additional, non-type material WAM S37383 (shell), WAM S37384 (2 shells), WAM S37389 (shell) from central section of D'Arcy Island, 15°17'22–31"S, 124°24'4–11"E.

Etymology

For Wurroolgu, name of Augustus Island in Worrorra, language of the Dambimangari people; noun in apposition.

Description

Shell (Fig. 58D, Table 4): Very large, globose to broadly conical, with well- to strongly elevated spire, body whorl largely expanded with compressed periphery, well rounded below, slightly shouldered above, suture relatively shallow; colour evenly yellowish green, inner lip whitish. Protoconch about 4.2 mm in diameter, comprising 1–1.5 whorls, with faint radial lirae only. Teleoconch with regular, faint axial growth lines supporting axial rows of tiny pustulation, evenly distributed across shell, reduced at base. Umbilicus forming chink. Aperture well rounded, wide, simple, moderately thick, basal node weak to absent, palatal node absent, parietal wall thin, white.

Genital anatomy (Figs. 68, 69): Penis tubular, not coiled within penial sheath, with thick glandular walls. Vas entering penial sheath within distal third of penial complex, entering penis through wide, simple pore that gives rise to a sperm gutter on distal half of inner penial

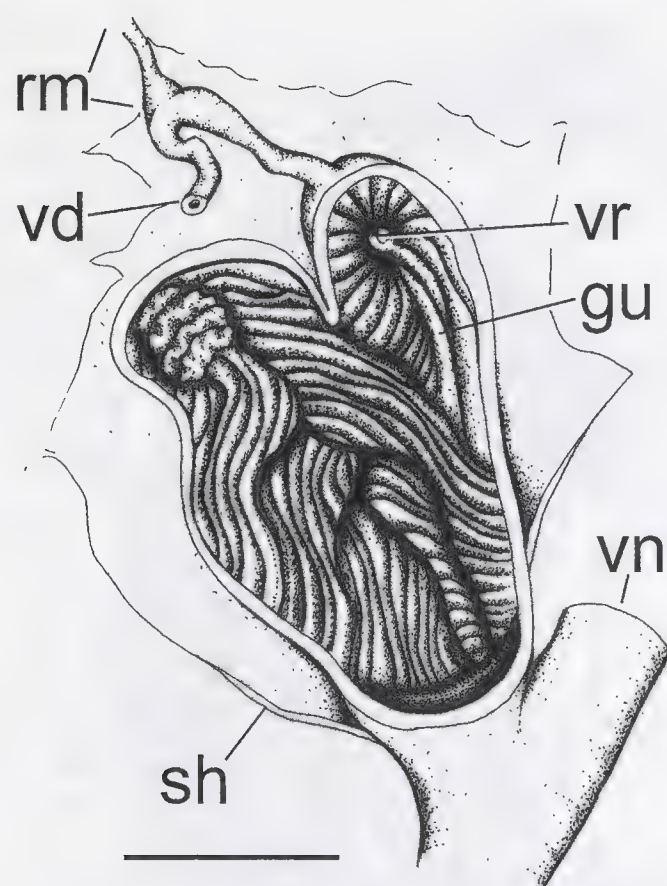


FIG. 69. Penial anatomy of *Globorhagada wurroolgu* n. sp. holotype WAM S37361 (Augustus Island, February). Scale bar = 3 mm.

wall; inner penial wall completely covered with narrow, regular, crowded, longitudinal lamellae that run almost parallel to this gutter. Anteriorly to these lamellae, strong, irregular pilasters or cords are forming on both sides of gutter running oblique-longitudinally in a sharp V-shaped direction. Vagina moderately long, tubular. Bursa copulatrix thick, with globular head, slightly extending anterior end of spermoviduct.

Mitochondrial Differentiation

Mean infraspecific sequence divergence 0.003 (one sequence each from Augustus and Champagne Islands); mean p-distances to other species of the *G. prudhoensis*-complex between 0.04 and 0.09; mean p-distances to species of the *G. ruberpumilio*-complex 0.23–0.24.

Comparative Remarks

Anatomical description based on dissection of two specimens. Differs most conspicuously from *G. prudhoensis* and *G. confusa* by distinct armature of inner penial wall, which exhibits lateral lamellae and oblique pilasters, while *G. prudhoensis* has crescent shaped, corrugated pads and *G. confusa* oblique lamellae. Shells of *G. wurroolgu* are smaller than those of former two species (Table 4).

Distribution (Fig. 57)

Northwestern section of Augustus Island and Champagne Island. Shells from D'Arcy Island, located in between these islands, are considered conspecific. Not found so far in southern part of August Island.

***Globorhagada yoowadan* n. sp.**
Figs. 70, 71

Type Locality

Western Australia, southwestern Kimberley, Doubtful Bay, southeastern section of Storr Island, 15°57'02"S, 124°33'39"E; coll. Vince Kessner, 20/05/2009, KIS 3-137 (dry vine thicket patch on S-facing sandstone ridge; under rocks).

Material Examined

Holotype WAM S58484 (preserved specimen). Paratypes AM C471859 (preserved animal, dissected), WAM S37735-7 (3 preserved specimens), WAM S37796-801 (8 shells) from southeastern section of Storr Island.

Additional, non-type material WAM S37738 (preserved specimen) WAM S37791 (preserved specimen), WAM S37862-4 (3 shells), WAM S37866 (3 shells) from unnamed island in Doubtful Bay, 15°54'36"-55°08"S, 124°27'39"-53"E.

Etymology

For Yoowadan, name of Storr Island in Worrorra, language of the Dambimangari people; noun in apposition.

Description

Shell (Table 4): Very large, globose to broadly conical, with well- to strongly elevated spire, body whorl largely expanded with compressed periphery, well rounded below, slightly shouldered above, suture relatively shallow; colour evenly yellowish green, inner lip whitish. Protoconch about 4.2 mm in diameter, comprising 1-1.5 whorls, with faint radial lirae only. Teleoconch with regular, faint axial growth lines supporting axial rows of tiny pustulation, evenly distributed across shell, reduced at base. Umbilicus forming a chink. Aperture well rounded, wide, simple, moderately thick, basal node weak to absent, palatal node absent, parietal wall thin, white.

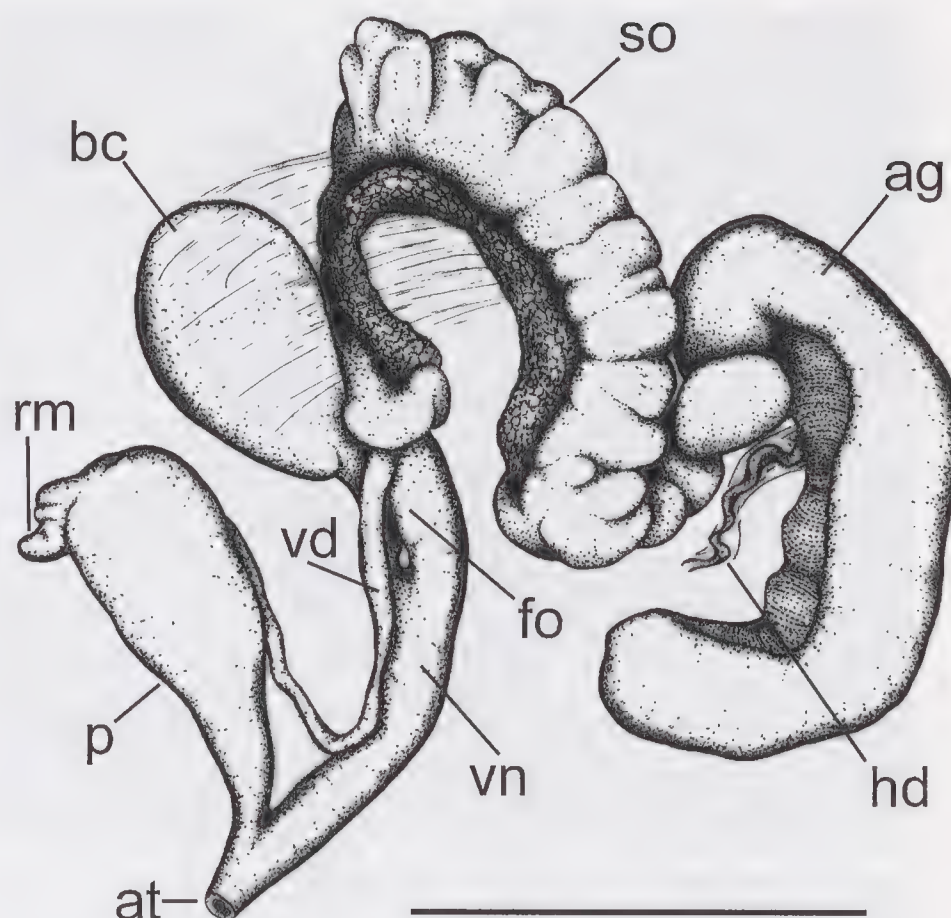


FIG. 70. Genital anatomy of *Globorhagada yoowadan* n. sp. holotype WAM S58484 (Storr Island, May). Scale bar = 10 mm.

Genital anatomy (Figs. 70-71): Penis long, cylindrical, not coiled within penial sheath, with thick glandular walls. Vas entering penial sheath within distal third of penial complex, entering penial lumen through wide, simple pore; inner penial wall completely covered with narrow, regular, crowded, obliquely longitudinal lamellae that run in a sharp V-shaped direction, forming a gutter; lamellar fields extending from distal end to near proximal end of interior wall, ending abruptly within proximal fifth of wall. Vagina long, tubular; bursa copulatrix thick, head hugely expanded, globular, slightly extending anterior end of spermatheca, connected to spermatheca by connective tissue; free oviduct shorter than vagina; spermatheca and albumen gland typical.

Mitochondrial Differentiation

Mean infraspecific sequence divergence 0.011 (four sequences, three from Storr Island, one from unnamed island, Doubtful Bay); mean p-distances to other species of the *G. prudhoeensis*-complex between 0.04 and 0.09; mean p-distances to species of the *G. ruberpumilio*-complex 0.21-0.24.

Comparative Remarks

No shell photos taken as holotype was cracked for dissection and other shells are not fully mature or worn. Anatomical description

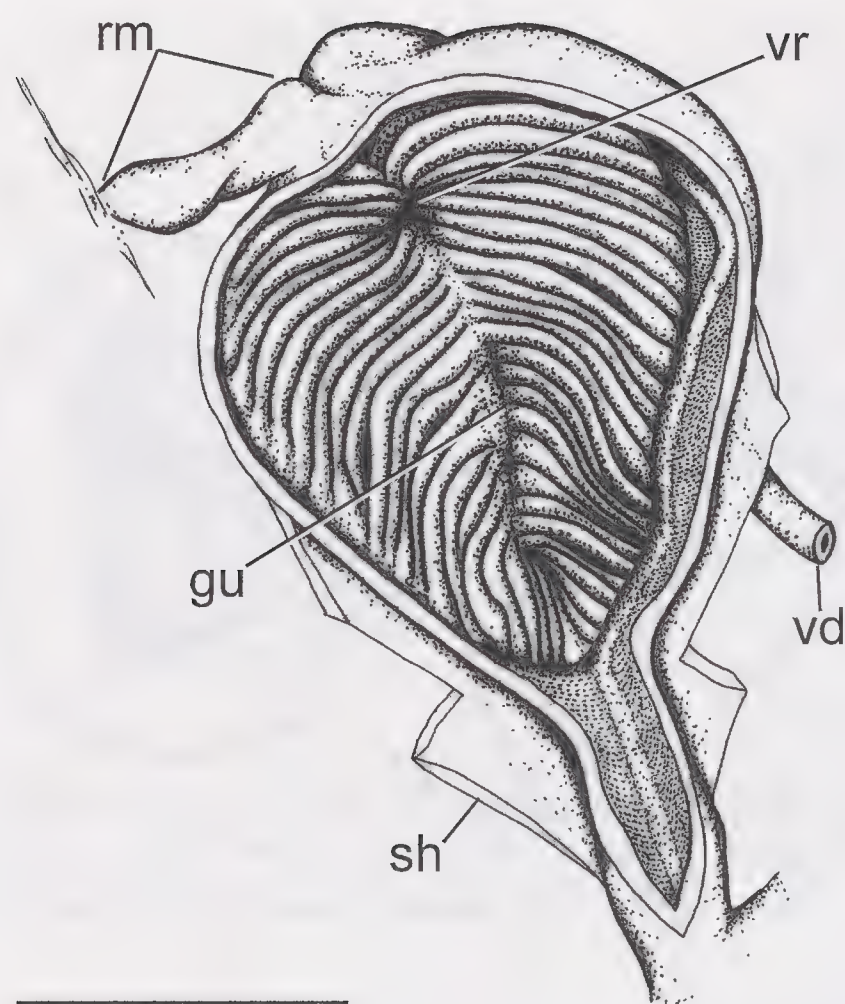


FIG. 71. Penial anatomy of *Globorhagada yoowadan* n. sp. holotype WAM S58484 (Storr Island, May). Scale bar = 10 mm.

based on dissection of one specimen. Differs most conspicuously from *G. prudhoensis* by distinct armature of inner penial wall, which exhibits oblique lamellae, while *G. prudhoensis* has crescent shaped, corrugated pads; similar to *G. confusa* with weaker sperm gutter, lamellae more regular and finer. Shells of *G. yoowadan* are slightly smaller than those of former two species (Table 4).

Distribution (Fig. 57)

Known from Storr Island and unnamed island in Doubtful Bay, probably also to be found on adjacent mainland.

Globorhagada ruberpumilio Complex

This complex contains species with similar shells that are characterised by distinct penial wall anatomy and separated by relatively low infraspecific genetic p-distances in 16S.

Globorhagada wunandarra n. sp.

Figs. 58E, 72–74

Type Locality

Western Australia, northwestern Kimberley, Bonaparte Archipelago, central section of Boongaree Island, 15°04'15"S, 125°11'14"E;

coll. Michael Shea, 9/08/2007, KIS 1–30 (sandstone boulders, dry woodland, vine thicket-grassland mix; sealed to bark under tree).

Material Examined

Holotype WAM S36635 (preserved specimen, dissected). Paratypes AM C471861 (6 preserved specimens), WAM S37623 (3 preserved specimens), WAM S37624 (15 preserved specimens), WAM S37625 (preserved specimen), WAM S36634 (preserved specimen), AM C471860 (shell), WAM S36446–8 (6 shells), WAM S36487 (shell), WAM S36952 (shell) from central section of Boongaree Island.

Etymology

For Wunandarra, name of Boongaree Island in Wunambal, language of the Unguu people; noun in apposition.

Description

Shell (Figs. 58E, 72A–D, Table 4): Moderate in size (small for the genus), globose, with highly elevated spire, last whorl extremely increased in height and diameter, accounting for two thirds of entire shell height, depressed at periphery, well rounded below, slightly shouldered above; suture shallow. Protoconch 3.4 mm in diameter, comprising about one whorl, essentially smooth with only faint radial growth lines. Teleoconch with conspicuous sculpture on upper half of whorls consisting of delicate axial growth lines that support dense axial rows of microscopic pustules, particularly prominent on penultimate and last whorl, pustulation absent from lower part of last whorl and base of shell. Colour chestnut brown with beige to light brown suffusion at base of shell, outer lip colour may be darker than shell, inner lip purplish brown. Umbilicus partly to almost completely concealed, forming a narrow opening or chink. Apertural lip well rounded, simple, flaring, sharp, nodes absent, parietal wall inconspicuous.

Radula (Fig. 72E, F): 3.5–5.5 mm long; C + 18 + 3–4 + 10–22.

Genital anatomy (Figs. 73–74): Penis long, cylindrical, not coiled within penial sheath, with thick glandular walls. Vas entering penial sheath within distal third of penial complex, opening into penial lumen through a simple pore; interior penial wall densely covered with extremely minute pustules, one smooth,

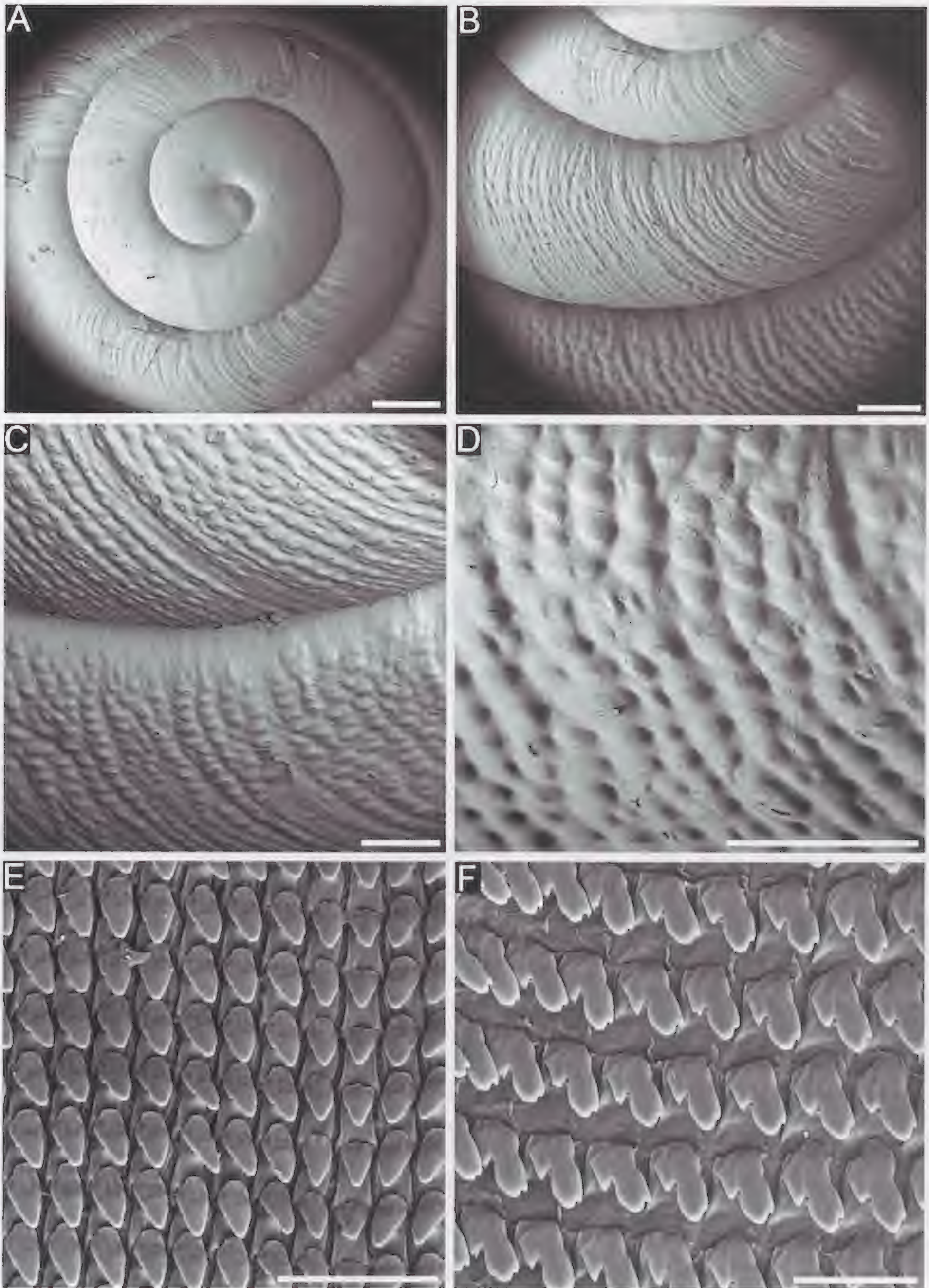


FIG. 72. SEM micrographs of *Globorhagada wunandarra* (Boongaree Island). A–D: Shell (paratype AM C471860). Scale bars = 1 mm. A: Apical view showing protoconch; B: Sculpture on second to fourth whorl viewed from above; C: Sculpture near suture on penultimate whorl; D: Close-up of sculpture on penultimate whorl; E–F: Radula (holotype WAM S36635). E: Central and inner lateral teeth viewed from above. Scale bar = 100 µm; F: Close-up of middle marginal teeth viewed from above. Scale bar = 50 µm.

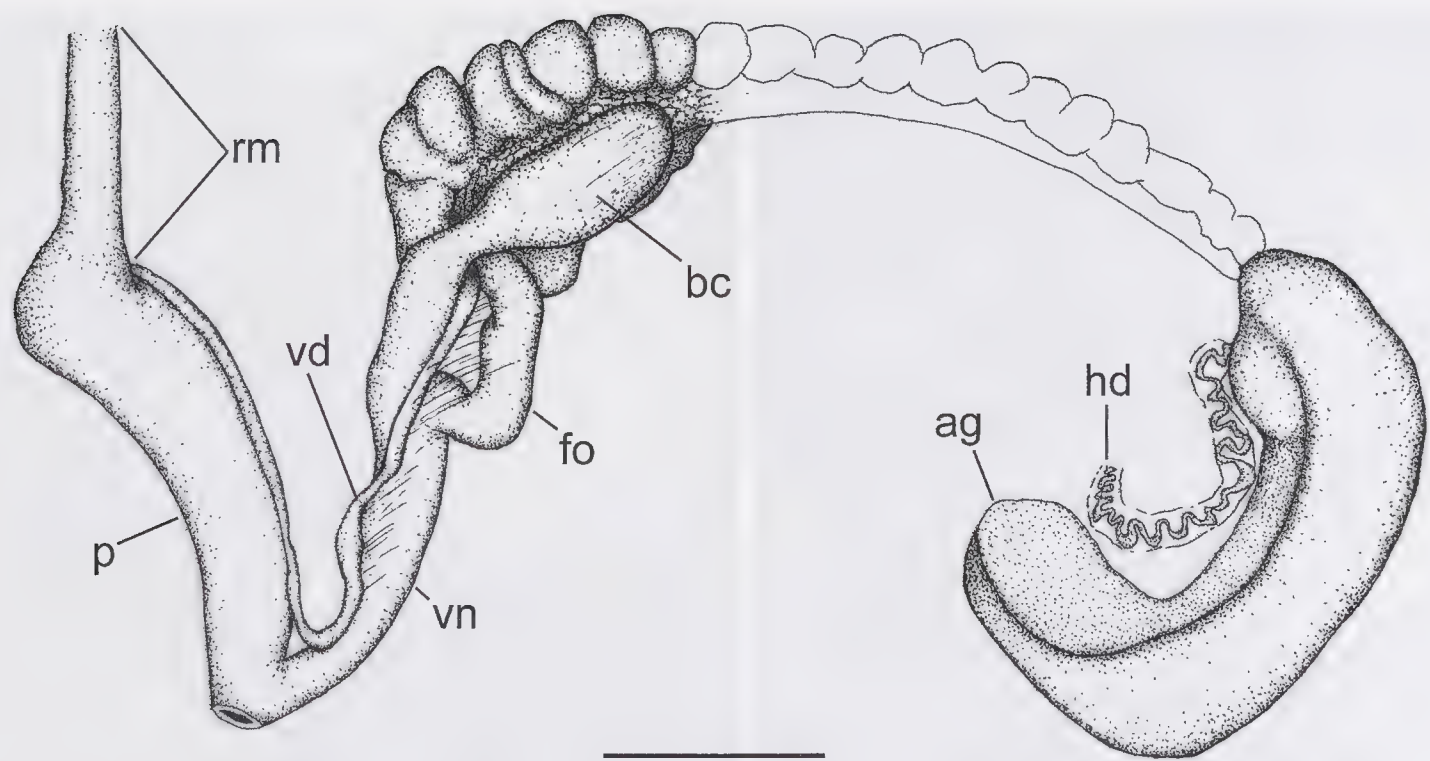


FIG. 73. Genital anatomy of *Globorhagada wunandarra* n. sp. holotype WAM S36635 (Boongaree Island, August). Schematic parts of spermoviduct reconstructed. Scale bar = 5 mm.

indistinct longitudinal pilaster may be present, lamellae or additional folds. Vagina long, bursa copulatrix wide, head well differentiated, inflated, connected to base of spermoviduct by connective tissue; free oviduct shorter than vagina, spermoviduct longer than anterior part of oviduct; albumen gland typical, large.

Mitochondrial Differentiation

Mean infraspecific sequence divergence 0.004 (two sequences); mean p-distances to other species of the *G. ruberpumilio*-complex between 0.10 and 0.18; mean p-distances to species of the *G. prudhoensis*-complex 0.24–0.27.

Comparative Remarks

Shell typical of the *G. ruberpumilio*-complex, differing from *G. ruberpumilio* (from Youwanjela Creek, Prince Regent Reserve) and *G. uwinsensis* by more pronounced microsculpture on upper part of last teleoconch whorls and larger shell ($D = 20.6\text{--}22.3$ mm instead of $17.7\text{--}20.5$ mm; as given by Solem, 1979; Table 4). In addition, penial wall lacking longitudinal folds and two flanking pilasters next to entrance of vas deferens near proximal end of interior surface of penial wall as reported for *G. ruberpumilio* by Solem (1979: fig. 6).

Distribution (Fig. 57)

Boongaree Island.

Globorhagada uwinsensis n. sp.
Figs. 58F, 75–77

Type Locality

Western Australia, central Kimberley coast, Bonaparte Archipelago, Hanover Bay, Uwins Island, $15^{\circ}15'32''\text{S}$, $124^{\circ}48'08''\text{E}$; col. Vince Kes-

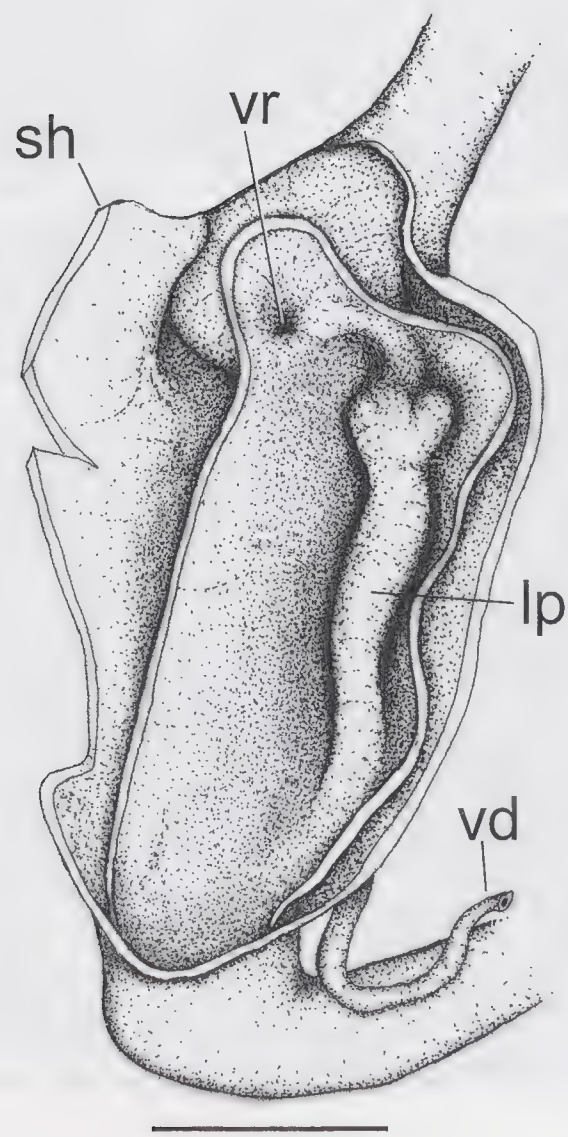


FIG. 74. Penial anatomy of *Globorhagada wunandarra* n. sp. holotype WAM S36635 (Boongaree Island, August). Scale bar = 3 mm.

snail, 08/02/2009, KIS 3–130 (vine thicket, large fig trees on upper slopes, piles of sandstone rocks; active on ground after rain at night).

Material Examined

Holotype WAM S37626 (preserved specimen, dissected). Paratypes WAM S58485 (preserved specimen), AM C471862 (preserved animal, dissected), WAM S37627 (preserved specimen), WAM S36992–4 (3 preserved specimens), WAM S37085 (preserved specimen), AM C471863 (shell), WAM S37242–7 (17 shells) from Uwins Island.

Etymology

For Uwins Island, adjective.

Description

Shell (Figs. 58F, 75, Table 4): Very small for the genus, globose, with moderately elevated spire, last whorl extremely increased in height and diameter, accounting for two thirds of entire shell height, whorls well rounded below, slightly shouldered above slightly depressed at periphery; suture shallow. Protoconch 3.4 mm in diameter, about one whorl, smooth with only faint radial growth lines. Teleoconch with delicate axial growth lines, dense axial rows of microscopic pustules forming only immediately underneath suture on upper parts of penultimate and last whorl. Colour chestnut brown with beige to light brown suffusion at base of shell, outer lip colour may be darker than shell, inner lip purplish brown. Umbilicus partly concealed (0–40%).

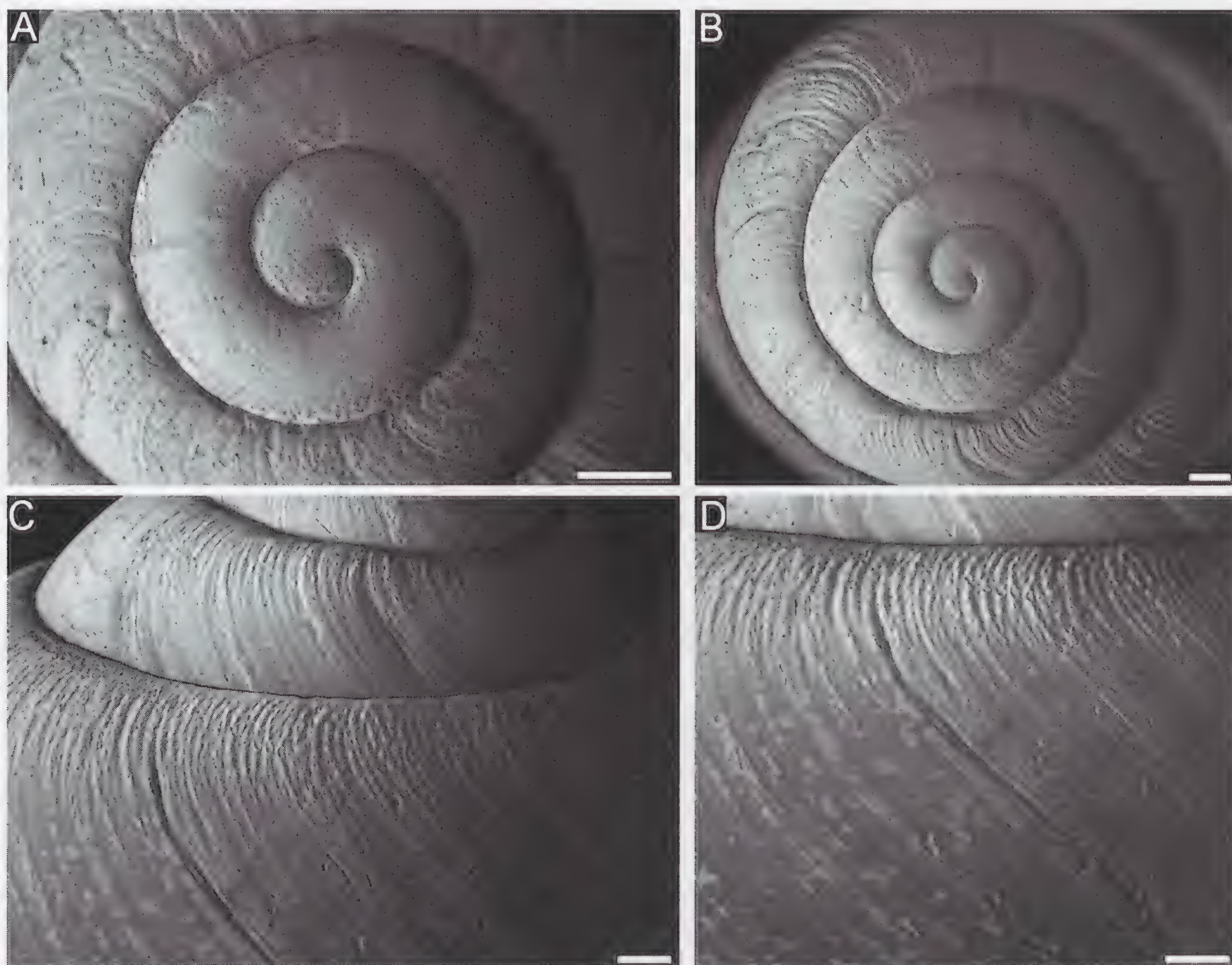


FIG. 75. SEM micrographs of the shell of *Globorhagada uwinsensis* n. sp. paratype AM C471863 (Uwins Island). A: Apical view showing protoconch; B: Apical view showing sculpture on first whorls; C: Lateral view showing sculpture on third and penultimate whorl; D: Close-up of sculpture on upper part of penultimate whorl. Scale bars = 1 mm.

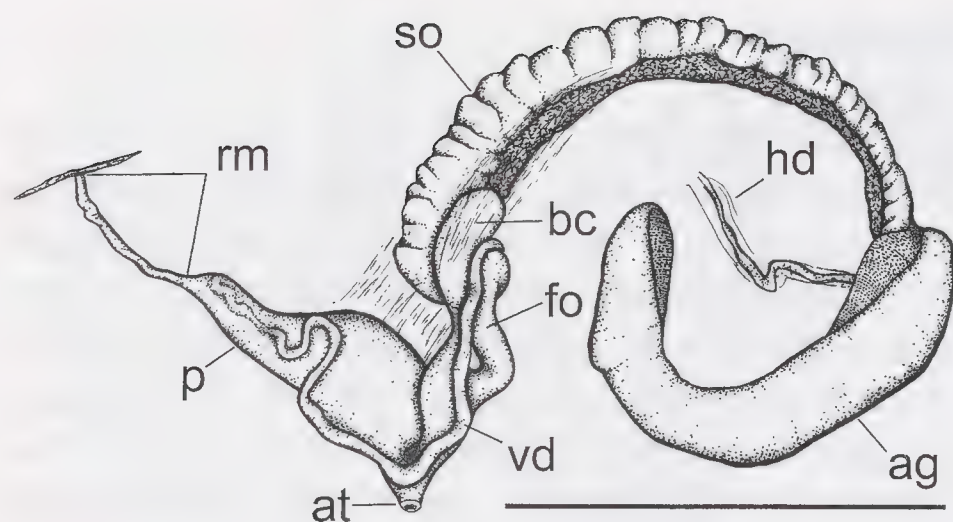


FIG. 76. Genital anatomy of *Globorhagada uwinsensis* n. sp. paratype AM C471862 (Uwins Island, February). Schematic parts of spermoviduct reconstructed. Scale bar = 5 mm.

Apertural lip well rounded, simple, flaring, sharp, nodes absent, parietal wall inconspicuous.

Genital anatomy (Figs. 76–77): Penis moderately long, bulbous, not coiled within penial sheath, with thick glandular walls. Vas entering penial sheath within distal third of penial complex, opening into penial lumen through simple vergic ring that gives rise to sperm gutter running along interior penial wall till proximal end; sperm gutter flanked by pad-like thickenings on each side, which support delicate, dense lateral lamellae; these lamellar pads extend to proximal end of penial wall, tapering in thickness. Vagina rather short, about as long as free oviduct. Bursa copulatrix wide, head inflated.

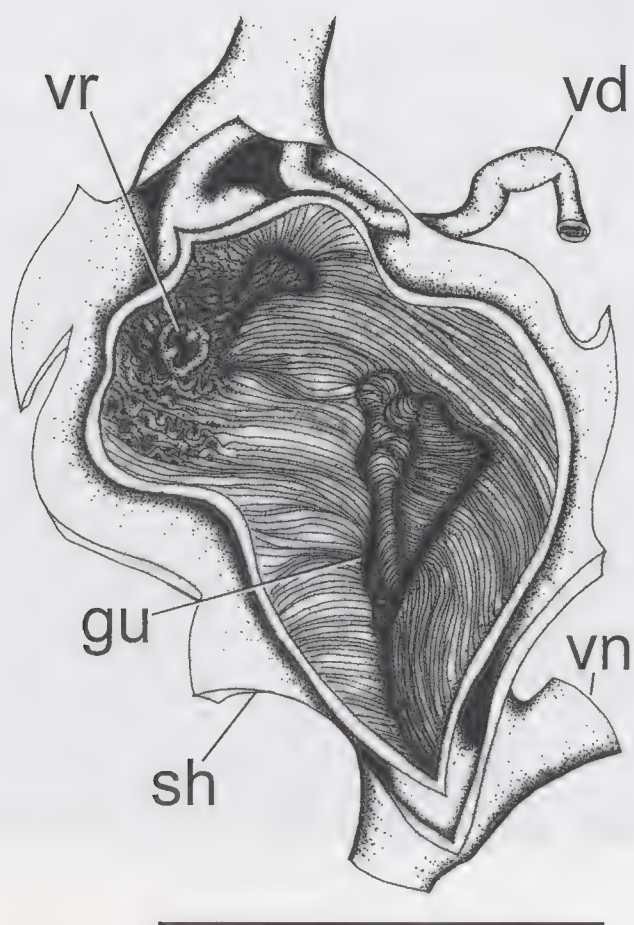


FIG. 77. Penial anatomy of *Globorhagada uwinsensis* n. sp. paratype AM C471862 (Uwins Island, February). Scale bar = 3 mm.

Comparative Remarks

Shell typical of *G. ruberpumilio* complex; smaller than *G. wunandarra* from Boongaree Island (Table 4), but of similar size as *G. ruberpumilio*; sculpture of microscopic pustulation much weaker than in *G. wunandarra* and found only immediately underneath suture. Penial anatomy differs by presence of lateral lamellae. Penial anatomy of *G. ruberpumilio* differs by presence of weak, irregular longitudinal pilasters.

Distribution (Fig. 57)

Uwins Island.

Rhagada Albers, 1860

Rhagada Albers, 1860 [in Martens & Albers]: 108–109; Pilsbry, 1890: 185–191; 1894: 135–136; Preston, 1908: 120; 1914: 13; Hedley, 1916: 69–70; Iredale, 1938: 112–113; 1939: 58–63; Solem, 1985a: 875–919; 1985b: 143–136; 1991: 217–218; 1997: 1663–1789; Solem & McKenzie, 1991: 247–263; Johnson & Black, 1991: 367–374; Withers et al., 1997: 599–611; Johnson et al., 2004: 341–355; 2006: 45–50; Maassen, 2009: 65–69. Type species: *Helix reinga* Pfeiffer, 1846, by original designation.

Bellrhagada Iredale, 1938: 114; Iredale, 1939: 71–72. Type species: *Rhagada plicata* Preston, 1914, by original designation.

Tumegada Iredale, 1939: 62. Type species: *Helix convicta* Cox, 1876, by original designation.

Taxonomic Remarks

The Western Australian species were revised by Solem (1985a, 1991, 1997), who also suggested synonymy of *Bellrhagada* and *Tumegada*. Maassen (2009) briefly revised the Indonesian *Rhagada* species known from Bali, Solor, Sumba, Flores and Alor.

Diagnosis

Shell: Small to medium sized ($D = 9\text{--}25$ mm; Table 5), thin to moderately thick, nearly flat to globose with moderately to strongly elevated, exceptionally also low spire; umbilicus frequently closed by greatly expanded callus, occasionally not fully concealed forming a chink; protoconch smooth to weakly sculptured by radial ridglets or ribs; teleoconch with faint to well-developed sculpture of irregular, axial ridglets or ribs, mostly

TABLE 5. Shell parameters of *Rhagada* (in mm), given are maximum – minimum (mean ± standard deviation) for N measured specimens. Abbreviations used: HT = holotype.

Species	N	Height (H)	Diameter (D)	Height of First Whorl (FW)	Whorls	H/D Ratio
<i>R. biggeana</i> n. sp.	4	8.6–10.5 (9.9 ± 0.7)	13.7–15.3 (14.5 ± 0.8)	6.2–7.0 (6.6 ± 0.4)	4.6–4.8 (4.8 ± 0.1)	0.63–0.72 (0.68 ± 0.03)
<i>R. sheaei</i> n. sp.	18	10.6–14.3 (12.3 ± 0.9)	15.6–20.3 (17.9 ± 1.1)	7.1–9.0 (7.9 ± 0.5)	4.5–5.3 (4.9 ± 0.2)	0.61–0.76 (0.68 ± 0.03)
<i>R. felicitas</i> n. sp.	HT	8.8	13.1	6.0	5.25	0.67
	25	7.4–9.5 (8.3 ± 0.5)	11.5–14.3 (13.0 ± 0.7)	4.8–6.0 (5.4 ± 0.3)	4.2–5.0 (4.6 ± 0.2)	0.58–0.71 (0.64 ± 0.03)
<i>R. cygna</i>						
Sunday Is	6	7.0–8.2 (7.6 ± 0.4)	11.1–12.7 (11.9 ± 0.6)	5.1–5.6 (5.4 ± 0.2)	4.1–4.4 (4.2 ± 0.1)	0.60–0.68 (0.64 ± 0.03)
Hidden Is	16	7.6–9.2 (8.5 ± 0.5)	12.0–13.5 (12.7 ± 0.5)	5.4–6.2 (5.7 ± 0.2)	4.0–4.5 (4.3 ± 0.1)	0.61–0.73 (0.67 ± 0.04)
<i>R. dominica</i> n. sp.	HT	14.4	21.0	9.4	5.1	0.68
	24	11.0–14.9 (12.5 ± 0.8)	16.5–20.0 (18.3 ± 0.8)	7.7–9.0 (8.2 ± 0.4)	4.7–5.3 (5.5 ± 0.2)	0.62–0.82 (0.69 ± 0.05)
<i>R. primigena</i> n. sp.	HT	8.8	15.1	6.4	4.7	0.58
	18	8.5–10.0 (9.0 ± 0.4)	13.7–16.1 (14.8 ± 0.6)	5.8–6.7 (6.2 ± 0.3)	4.4–4.7 (4.5 ± 0.0)	0.56–0.69 (0.61 ± 0.03)

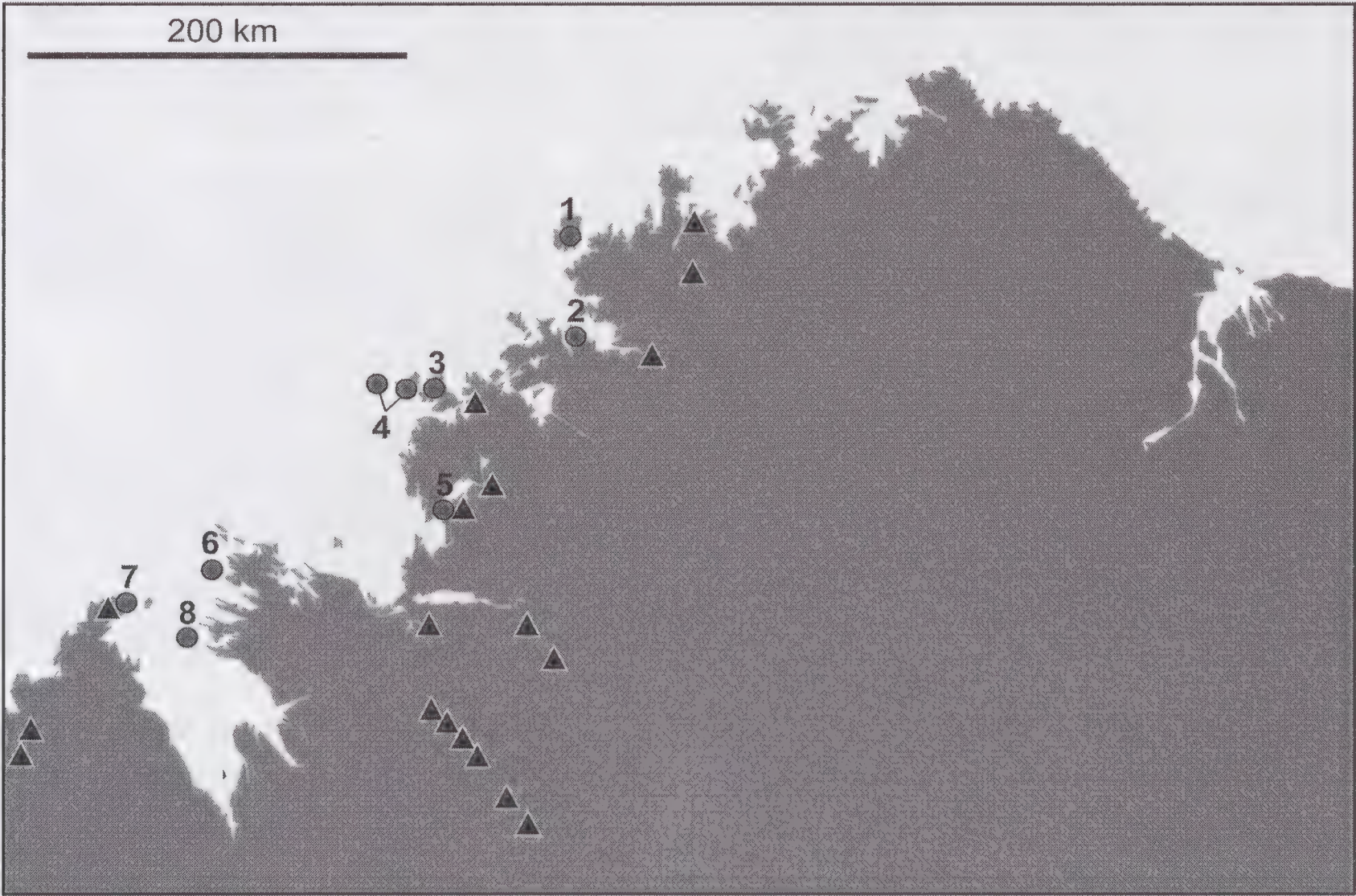


FIG. 78. Distribution map of *Rhagada*. Circles = records of species treated herein: 1: *R. biggeana* (Bigge Island), 2: *Rhagada* sp. (Boongaree Island), 3: *R. kessneri* (NW Augustus Island), 4: *R. sheaei* (Byam Martin and Chamapgny Islands), 5: *R. felicitas* (Storr Island), 6: *R. cygna* (Hidden Island), 7: *R. cygna*, *R. dominica* (Sunday Island), 8: *R. primigena* (Long Island); triangles = records of various species listed by Solem (1991).

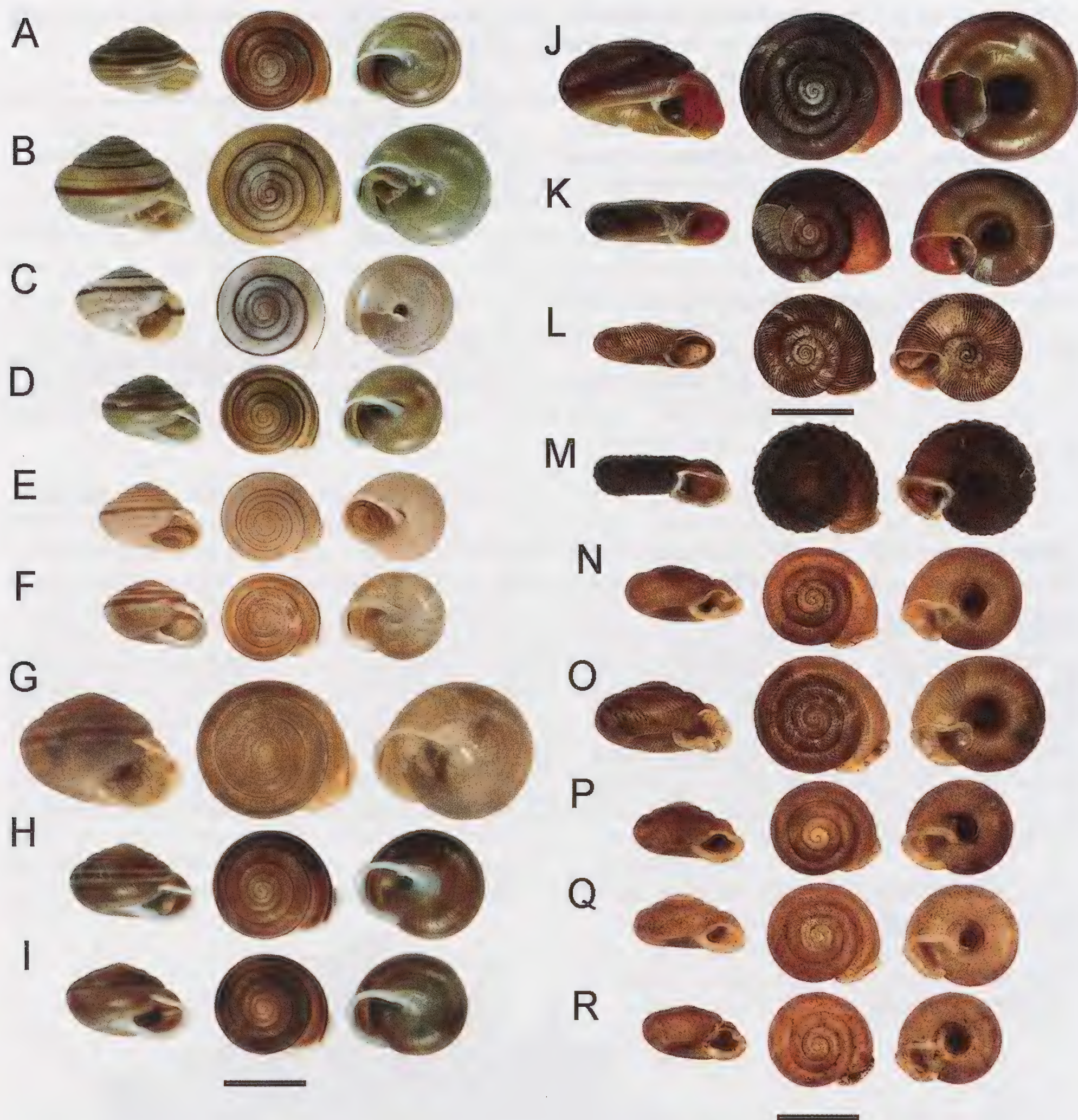


FIG. 79. Shells of *Rhagada*, *Retroterra*, *Molema* and *Baudinella*. A: *Rhagada biggeana* n. sp. paratype WAM S58486 (Bigge Island); B: *Rhagada sheaei* n. sp. paratype WAM S37074 (Byam Martin Island); C: *R. sheaei* n. sp. WAM S37693 (subadult, Champagny Island); D: *Rhagada felicitas* n. sp. holotype WAM S58487 (Storr Island); E: *Rhagada cygna* WAM S37728 (Hidden Island); F: *R. cygna* WAM S37831 (Sunday Island); G: *Rhagada dominica* n. sp. holotype WAM S58488 (Sunday Island); H: *Rhagada primigena* n. sp. holotype WAM S37721 (Long Island); I: *R. primigena* n. sp. paratype WAM S37719 (Long Island); J: *Retroterra aequabilis* n. sp. holotype WAM S58448 (Boongaree Island); K: *Retroterra discoidea* n. sp. holotype WAM S58449 (Uwins Island); L: *Retroterra acutocostata* n. sp. paratype WAM S37644 (1.3 km S of Halfway Bay); M: *Molema stankowskii* n. sp. holotype WAM S58447 (Molema Island). N: *Baudinella thielei* n. sp. paratype WAM S36975 (Bigge Island); O: *Baudinella boongareensis* n. sp. paratype WAM S37686 (Boongaree Island); P: *Baudinella tuberculata* n. sp. paratype WAM S37259 (Coronation Island); Q: *Baudinella setobaudinioides* n. sp. paratype WAM S37267 (Augustus Island); R: *Baudinella occidentalis* n. sp. paratype WAM S49043 (D'Arcy Island). Scale bars A–L = 10 mm; M–R = 20 mm. Note that foot protrudes from some shells.

on upper sector of whorls, with underlying vague calcareous undulations; whorls moderately increasing, separated by shallow to flat suture; periphery well rounded to weakly angulated. Shell colour variable, banded, background often whitish or brownish horn, with well-developed, red subsutural, supra-peripheral and frequently additional, thinner spiral bands. Head with

eversible head wart opening between and just posterior to ommatophores.

Genital anatomy: Penis without penial sheath, embedded into connective tissue, with well-developed, long and coiled epiphallus that supports an epiphallic flagellum of variable length. Penial retractor muscle attached at epiphallus. Epiphallus opens to lumen of



FIG. 80. SEM micrographs of shells of *Rhagada* species. A–C: *Rhagada biggeana* n. sp. paratype AM C471865 (Bigge Island). A: Apical view showing protoconch; B: Close-up of sculpture on second to third whorl; C: Close-up of sculpture on last whorl; D–F: *Rhagada sheaei* n. sp. paratype AM C471867 (Byam Martin Island). D: Apical view showing protoconch; E: Close-up of sculpture on second to third whorl; F: Close-up of sculpture on last whorl; G–I: *Rhagada felicitas* n. sp. paratype AM C471870 (Storr Island). G: Apical view showing protoconch; H: Close-up of sculpture on second to third whorl; I: Close-up of sculpture on last whorl. Scale bars: A, D, G = 1 mm; B–C, E–F, H–I = 500 μ m.

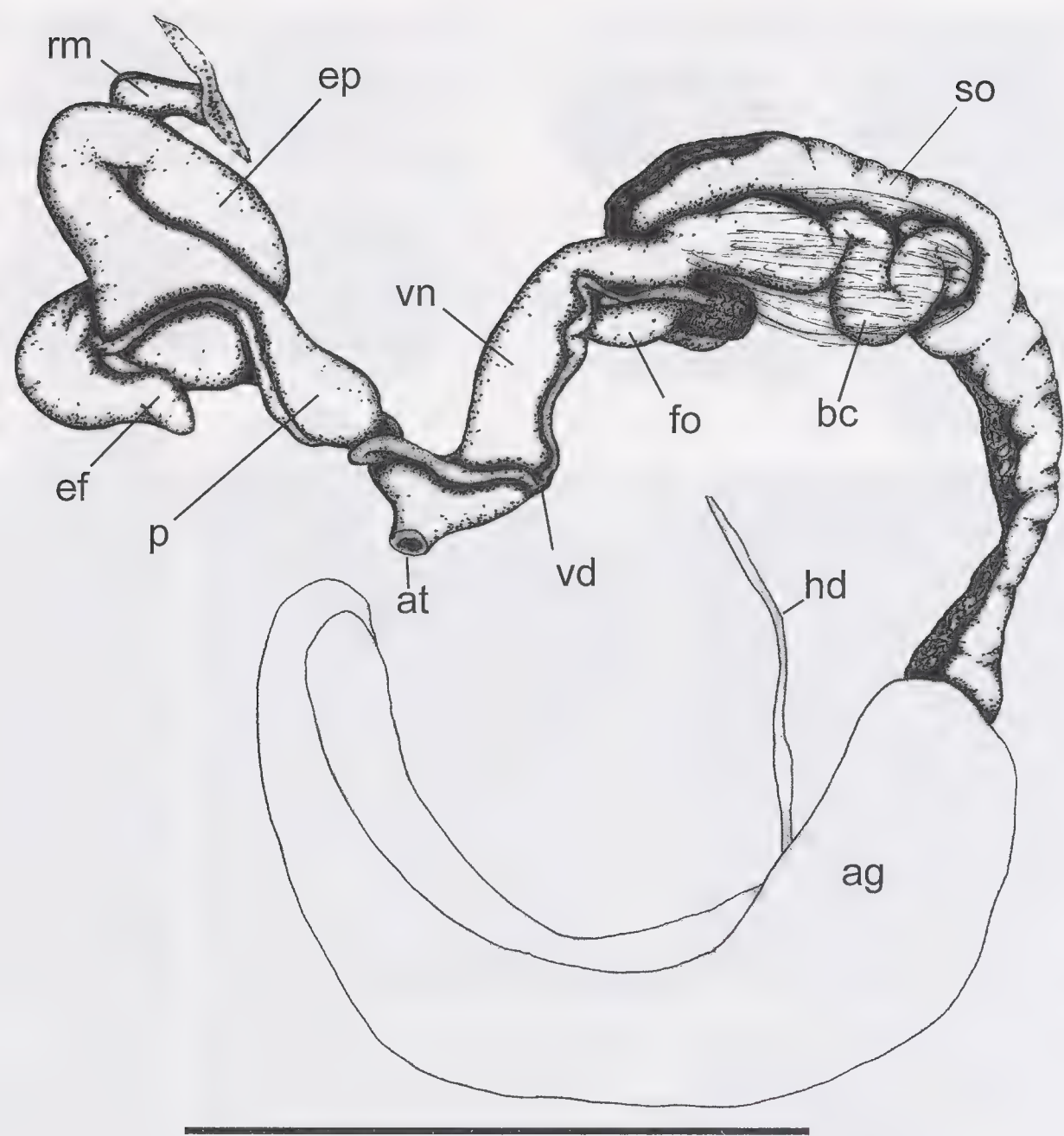


FIG. 81. Genital anatomy of *Rhagada biggeana* n. sp. holotype WAM S36739 (Bigge Island, August). Scale bar = 10 mm.

penial chamber through large, cone-shaped verge with characteristic sperm groove running down from opening of channel at tip of verge. Bursa copulatrix short to long, simple to kinked.

Aestivation Strategy

Free sealer (modified after Solem, 1997).

Diversity and distribution (Fig. 78)

Widespread in coastal regions of Western Australia between Shark Bay and Mitchell Plateau. In Indonesia, known from some of the Smaller Sunda Islands; likely widespread between Timor and Bali. Solem’s (1997) statement that *Rhagada* is an Australian endemic is refuted based on molecular evidence (Köhler, unpubl. data). Twenty-six species currently known from Western Australia; six additional species described herein. Dry and worn shells found on Boongaree Island do not permit identification but are thought to represent a further undescribed species (WAM S36043).

Rhagada biggeana n. sp.
Figs. 79A, 80A–C, 81, 82

Type Locality

Northwestern Kimberley, Bonaparte Archipelago, W coast of Bigge Island, 9.15 km NW of Savage Hill, 14°34’59”S, 125°06’22”E; coll. Michael Shea, 3/08/2007, KIS 1–19 (low open woodland, sandstone over laterite).

Material Examined

Holotype WAM S36739 (preserved specimen, dissected). Paratypes WAM S58486 (preserved specimen), AM C471864 (shell), AM C471865 (2 shells), WAM S36042 (5 shells) from type locality; WAM S36040 (7 shells) from 14°35’14”S, 125°11’08”E; WAM S36041 (3 shells) from 14°35’06”S, 125°06’12”E.

Etymology

For Bigge Island, adjective of female gender.

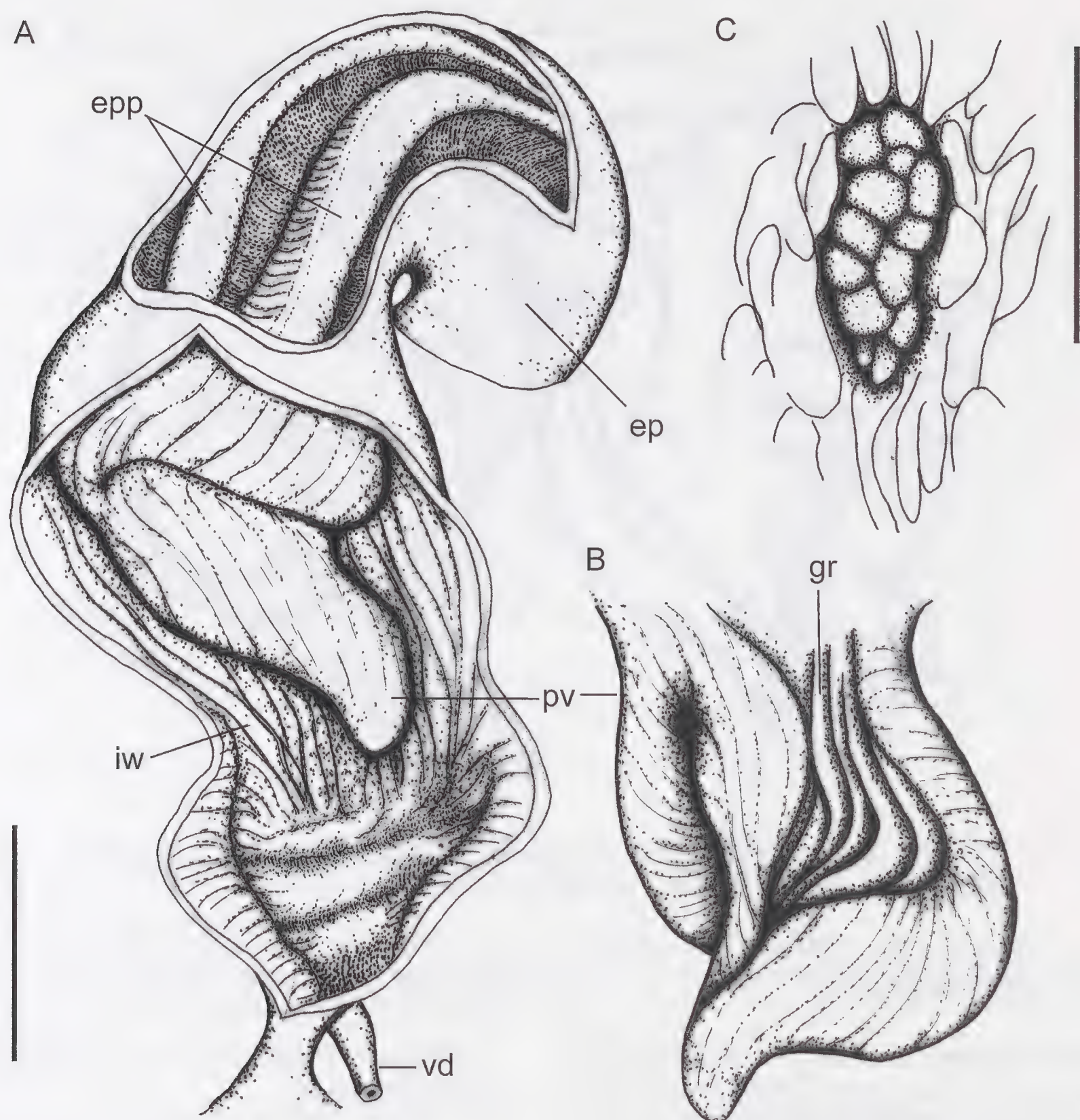


FIG. 82. Penial anatomy and head wart of *Rhagada biggeana* n. sp. holotype WAM S36739 (Bigge Island, August). A: Penial anatomy. Scale bar = 3 mm; B: Magnification of backside of penial verge; C: Head wart. Scale bar = 1 mm.

Description

Shell (Figs. 79A, 80A–C, Table 5): Small to moderate in size, thin to solid, broadly conical with moderately to conspicuously elevated spire; periphery well rounded to slightly depressed; last whorl well rounded above and below periphery; umbilicus closed ($\sim 2/3$ of adults) or forming a chink ($\sim 1/3$ of adults); background colour white; supra-peripheral band varying in development, usually well developed, rather thin to moderately thick, distinct, visible on all to most whorls; subsutural and additional spiral bands vary in number and development, thinner and lighter in colour. Protoconch ~ 2.6 mm in diameter, 1.5 whorls, smooth. Teleoconch smooth with faint radial growth lines. Angle of aperture $\sim 45^\circ$; last whorl abruptly descending behind lip; outer lip rounded, sharp to thin,

slightly expanded, basal node of lip weak, palatal node absent.

Genital anatomy and head wart (Figs. 81–82): Penis short, with slightly inflated proper and long, coiled epiphallus; distal two thirds of inner penial wall with weak longitudinal ridges, proximal third rather smooth; inner epiphallic wall with two well-developed longitudinal pilasters; penial verge large, conical, with pointed tip, extending more than half of length of penial chamber, kinked, smooth, groove supporting fine longitudinal lamellae. Head wart small, elongate-ovate (Fig. 82C).

Mitochondrial Differentiation

One specimen sequenced (holotype); inter-specific genetic distances: 0.11 with regard to *R. kessneri*, 0.20–0.22 to all other congeners.

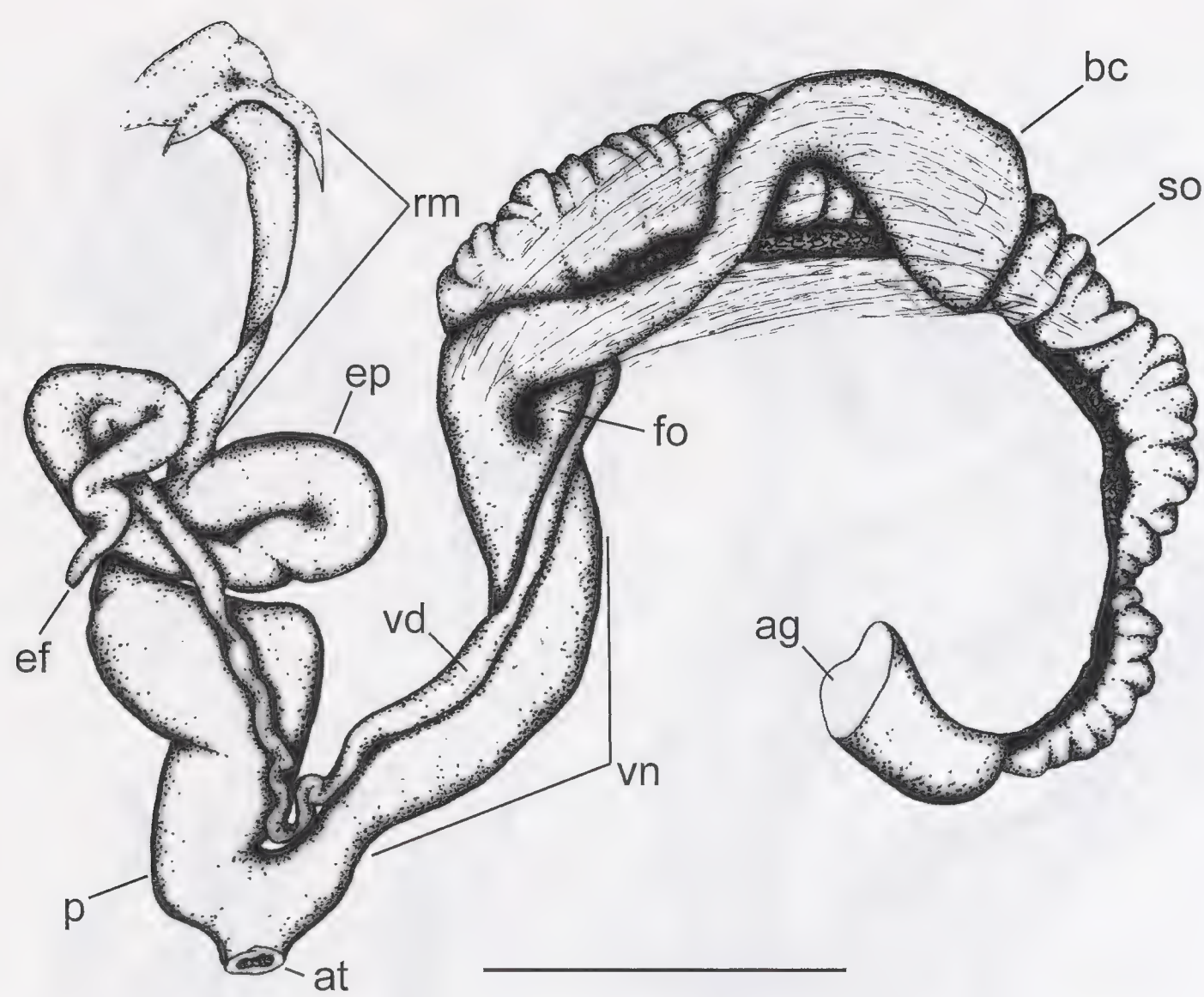


FIG. 83. Genital anatomy of *Rhagada kessneri* n. sp. holotype WAM S37678 (Augustus Island, February). Scale bar = 5 mm.

Comparative Remarks

Description based on worn or leached shells plus dissection of holotype. Genetic distances support status as distinct species with respect to all other congeners studied herein. Similarly, *R. kessneri* from Augustus Island has a large, conical verge and well-developed longitudinal epiphallic pilasters but differs by weaker sculpture of inner penial wall, and rounded shape of head wart. Present species identical with “*Rhagada* species 1” listed by Solem (1991).

Distribution (Fig. 78)

Bigge Island.

Rhagada kessneri n. sp.
Figs. 83, 84

Type Locality

Central Kimberley coast, Bonaparte Archipelago, Camden Sound, NW section of Augustus Island, 15°20'11"S, 124°31'10"E; coll. Vince Kessner, 13/02/2009, KIS 1–67 (open woodland on moderately steep W-facing slopes at the base of sandstone cliffs).

Material Examined

Holotype WAM S37678 (preserved specimen, dissected).

Etymology

Named in honour of Vince Kessner (Adelaide River), in recognition of his most valuable contributions to successful implementation of the Kimberley Island Survey; noun in genitive case.

Description

Genital anatomy and head wart (Figs. 83–84): Penis moderately long, with slightly inflated proper and long, coiled epiphallus, well-developed epiphallic flagellum; penial wall thick proximally, thin distally, interiorly rather smooth with weak longitudinal folds at proximal end; inner epiphallic wall with one well-developed longitudinal pilaster; penial verge large, conical, with pointed tip, extending more than half of length of penial chamber, smooth with simple groove. Vagina strongly elongated; free part of oviduct very short, coiled; bursa copulatrix long, considerably extending anterior end of spermoviduct, connected to base of spermoviduct by connective tissue, head clearly

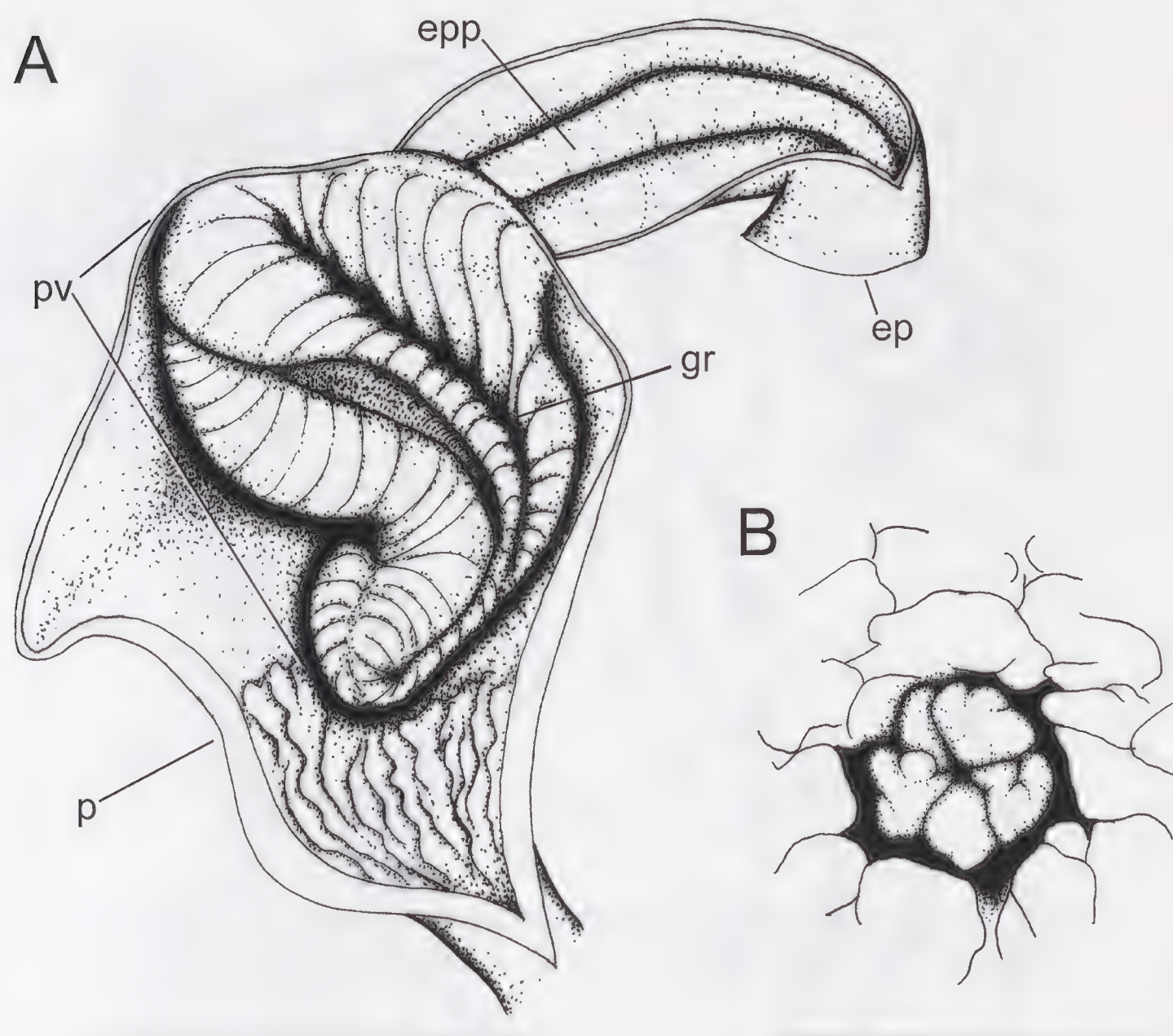


FIG. 84. Penial anatomy and head wart of *Rhagada kessneri* n. sp. holotype WAM S37678 (Augustus Island, February). A: Penial anatomy. Scale bar = 3 mm; B: Head wart. Scale bar = 1 mm.

differentiated, not kinked, inflated. Head wart small, round (Fig. 84C).

Mitochondrial Differentiation

One specimen sequenced (holotype); interspecific genetic distances: 0.11 to *R. biggeana*, 0.20–0.21 to all other congeners.

Comparative Remarks

Description based on dissection of one specimen with cracked shell. Genetic distances support distinct status with respect to all other congeners studied herein. *R. biggeana* is most similar for its large, conical verge and well-developed longitudinal epiphallallic pilasters but differs by stronger sculpture of inner penial wall, having two instead of one epiphallallic pilasters, more complex sperm groove of penial verge, elongate head wart.

Distribution (Fig. 78)

Known from northwestern Augustus Island only.

Rhagada sheaei n. sp.
Figs. 79B–C, 80D–F, 85, 86

Type Locality

Central Kimberley coast, Bonaparte Archipelago, Camden Sound, Byam Martin Island, 15°23'09"S, 124°21'42"E; coll. Michael Shea, 3/06/2009, KIS 1–61 (dry vine thicket patches, and eucalypts on S-facing slope, on sandstone).

Material Examined

Holotype WAM S37074 (dissected specimen). Paratypes WAM S49019 (shell) from type locality; WAM S37679 (preserved specimen), AM C471866 (7 shells), AM C471867 (shell), WAM S37302 (20 shells) from 15°23'10.6"S, 124°21'42.3"E. Additional non-type material WAM S37693 (preserved specimen) from Champagne Island, 15°18'26"S, 124°16'58"E.

Etymology

Named in honour of Michael Shea (Sydney), who collected some of the types.

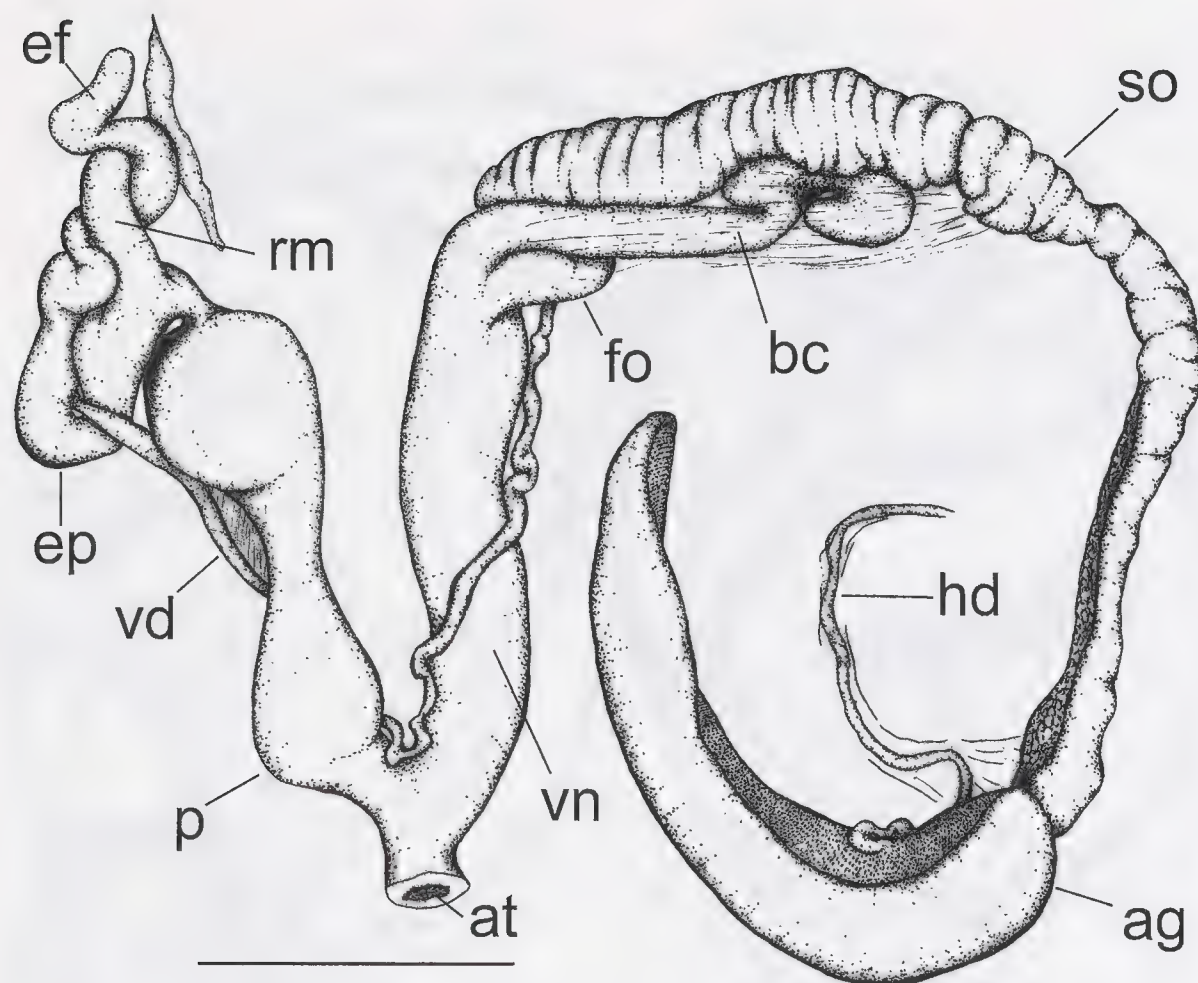


FIG. 85. Genital anatomy of *Rhagada sheaei* n. sp. holotype WAM S37074 (Byam Martin Island, June). Scale bar = 5 mm.

Description

Shell (Figs. Figs. 79B, C, 80D–F, Table 5): Moderate in size (comparatively large for genus), solid, broadly conical with strongly elevated spire; periphery slightly depressed to slightly angulated; last whorl well rounded above and below periphery; umbilicus closed ($\sim 2/3$ of adults) or forming a chink ($\sim 1/3$ of adults); background colour white, sometimes with reddish brown suffusion at upper whorls; supra-peripheral band usually strongly developed, moderately thick, distinct, visible on all or most whorls; subsutural band varies from absent to thick, additional spiral bands thinner and lighter in colour, varying in number from one to three above, nil to seven below supra-peripheral band, in development from diffuse to distinct. Protoconch ~ 3 mm in diameter, with 1.5–2 whorls, smooth. Teleoconch smooth with faint radial growth lines. Angle of aperture $\sim 45^\circ$; last whorl abruptly descending behind lip; outer lip rounded, slightly expanded, basal node of lip weak, palatal node absent.

Genital anatomy and head wart (Figs. 85–86): Penis moderately long, proximally and distally inflated with moderately long, coiled epiphallus, well-developed epiphallic flagellum; penial wall thick proximally, thin distally, interiorly smooth with faint oblique (distal) to longitudinal (proximal) folds and few weak longitudinal pilasters at proximal end; inner epiphallic wall with many fine longitudinal pilasters; penial verge large,

conical, with pointed tip, extending more than half of length of penial chamber, smooth with simple groove. Vagina strongly elongated; free part of oviduct very short, coiled; bursa copulatrix long, considerably extending anterior end of spermooviduct, connected to base of spermooviduct by connective tissue, head clearly differentiated, coiled or kinked, slightly inflated. Head wart small, irregularly shaped (Fig. 86C).

Mitochondrial Differentiation

Three specimens sequenced; infraspecific genetic distance 0.01 (on Byam Martin Island)–0.03 (between islands); interspecific genetic distance: 0.20–0.24 all other congeners.

Comparative Remarks

Description based on dissection of one specimen. Genetic distances support status as distinct species with respect to all other congeners studied herein. Shell larger than *R. biggeana* (Table 5); differs from *R. biggeana* and *R. kessneri* by number and development of epiphallic pilasters, kinked head of bursa copulatrix and different shape of head wart.

Distribution (Fig. 78)

Byam Martin and Champagny islands, Heywood Island group.

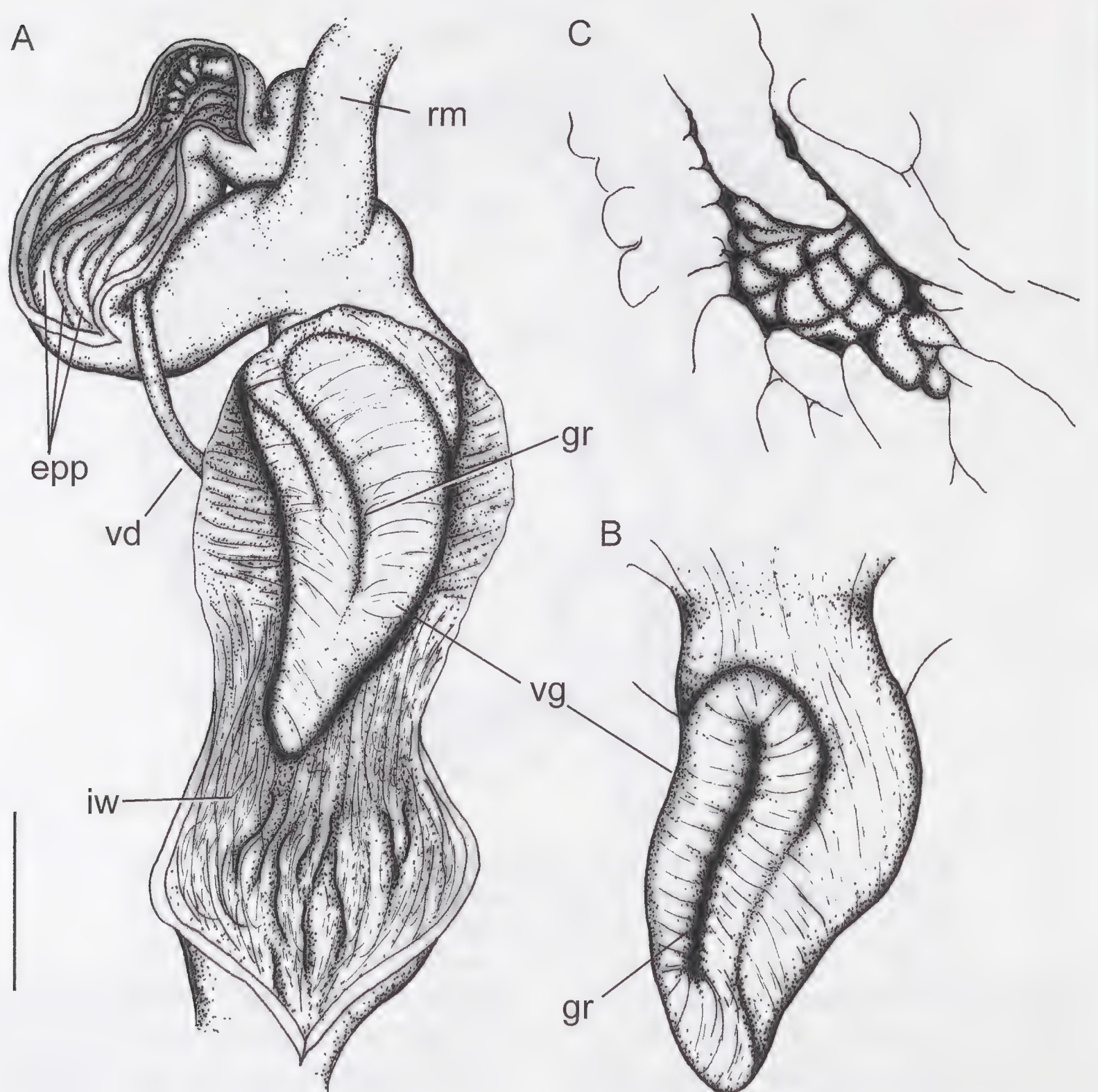


FIG. 86. Penial anatomy and head wart of *Rhagada sheaei* n. sp. holotype WAM S37074 (Byam Martin Island, June). A: Penial anatomy; B: Magnification of backside of penial verge; C: Head wart. Scale bars = 1 mm.

***Rhagada felicitas* n. sp.**

Figs. 79D, 80G–I, 87, 88

Type Locality

Western Australia, southwestern Kimberley, Doubtful Bay, southeastern section of Storr Island, 15°56'58"S, 124°33'24"E; coll. Vince Kessner, 21/05/2009, KIS 3–140 (in soil under rocks around roots of baobab tree on flat and open sandstone platform with talus and patches of *Spinifex*-grass).

Material Examined

Holotype WAM S58487 (preserved specimen). Paratypes AM C471868 (5 preserved specimens), WAM S37724 (14 preserved specimens), AM C471869 (15 shells), WAM S37838 (27 shells) from type locality; WAM S37722 (7 preserved specimens), WAM S37723 (7 pre-

served specimens), WAM S37725 (3 preserved specimens), WAM S37726 (3 preserved specimens), WAM S37727 (6 preserved specimens), AM C471870 (shell), WAM S37834 (4 shells), WAM S37835 (4 shells), WAM S37836 (4 shells), WAM S37837 (13 shells), WAM S37839 (4 shells), WAM S37840 (4 shells), WAM S37841 (3 shells) from southeastern section of Storr Island, 15°56'58"–57°40"S, 124°33'18–38"E.

Etymology

From "*felicitas*" (Latin = success, but also happiness) in reference to the name of Success Strait, north of Storr Island; noun in apposition.

Description

Shell (Figs. 79D, 80G–I, Table 5): Small, thin but solid, broadly conical with depressed spire; periphery well rounded to slightly angulated;

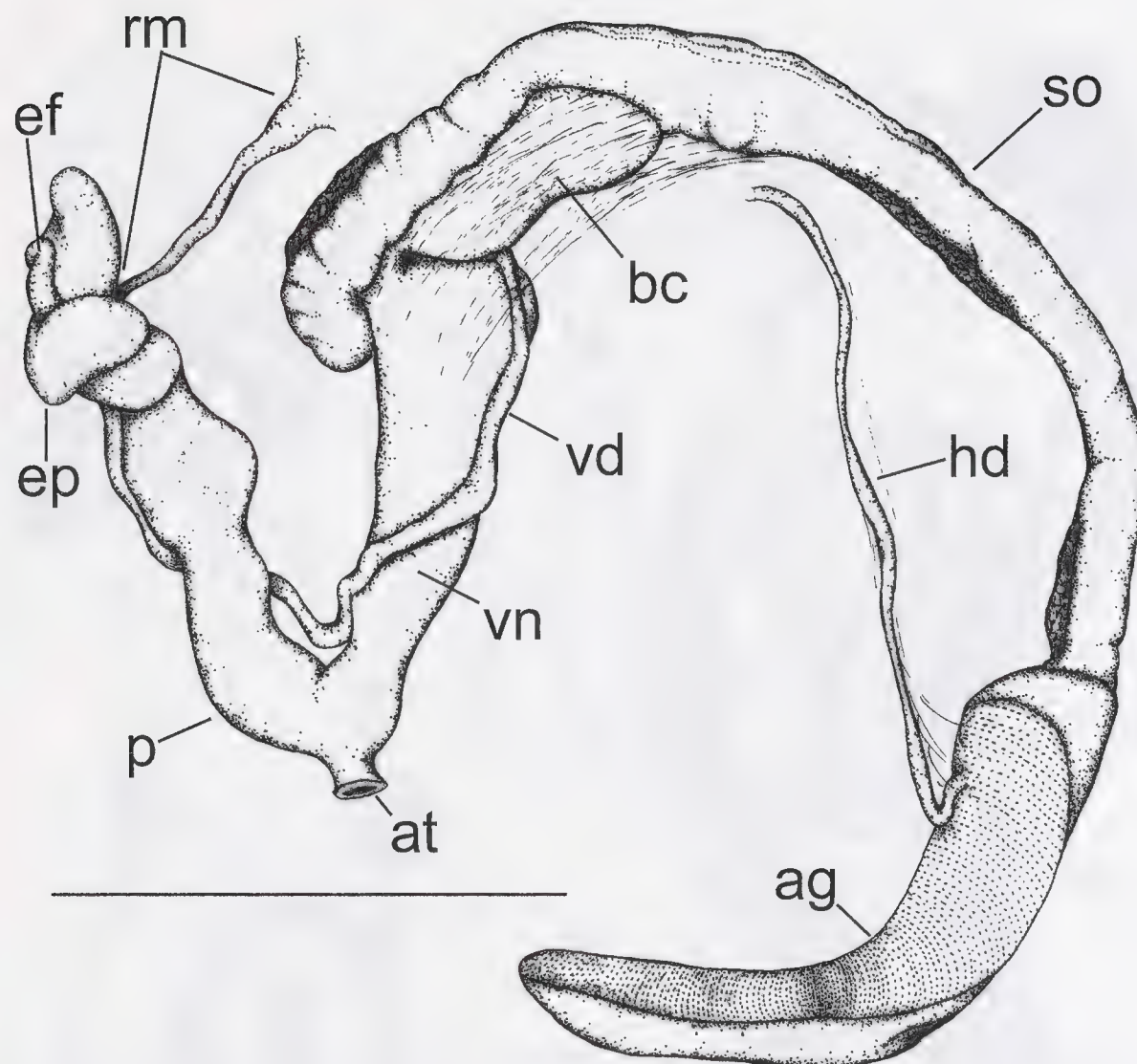


FIG. 87. Genital anatomy of *Rhagada felicitas* n. sp. holotype WAM S58487 (Storr Island, May). Scale bar = 3 mm.

last whorl well rounded above and below periphery; umbilicus closed ($\sim 1/3$ of adults) or forming a chink ($\sim 2/3$ of adults); background colour brownish horn to whitish; supra-peripheral band usually strongly developed, moderately thick, distinct, visible on all to most whorls; subsutural band varies from absent to thick, additional spiral bands thinner and lighter in colour, varying in number from one to three above, nil to two below supra-peripheral band, in development from diffuse to distinct; inner lip colour white. Protoconch ~ 2.6 mm in diameter, with 1.5 whorls, smooth. Teleoconch smooth with faint radial growth lines. Angle of aperture $\sim 45^\circ$; last whorl abruptly descending behind lip; outer lip rounded, slightly expanded, basal node of lip weak, palatal node absent.

Genital anatomy and head wart (Figs. 87–88): Penis moderately long, tubular with moderately long, tightly coiled epiphallus, short epiphallic flagellum; penial wall thick proximally, thin distally, interiorly with well-developed longitudinal pilasters comprising entire length of inner wall, pilasters join proximally; strong, corrugated main pilaster at centre of wall; inner epiphallic wall with two weak longitudinal pilasters; penial verge moderate in size, conical, with pointed tip, extending about half of length of penial chamber, with regular lateral corrugations;

simple, small groove. Vagina elongated, distally inflated; free part of oviduct very short, coiled; bursa copulatrix tubular, short, strongly inflated, extending anterior end of spermoviduct, not coiled or kinked. Head wart small, broad, irregularly shaped (Fig. 88C).

Mitochondrial Differentiation

Two specimens sequenced; infraspecific genetic distance 0.01; interspecific genetic distance: 0.19–0.22 all other congeners.

Comparative Remarks

Genetic distance to all other sequenced *Rhagada* samples supporting status as distinct species. Most characteristic features are well-developed longitudinal pilasters of inner penial wall, including corrugated main pilaster, laterally corrugated penial verge, and inflated bursa copulatrix, with undifferentiated head. Probably identical with '*Rhagada* species 2' listed by Solem (1991).

Distribution (Fig. 78)

Storr Island, Doubtful Bay, possibly also on adjacent mainland.

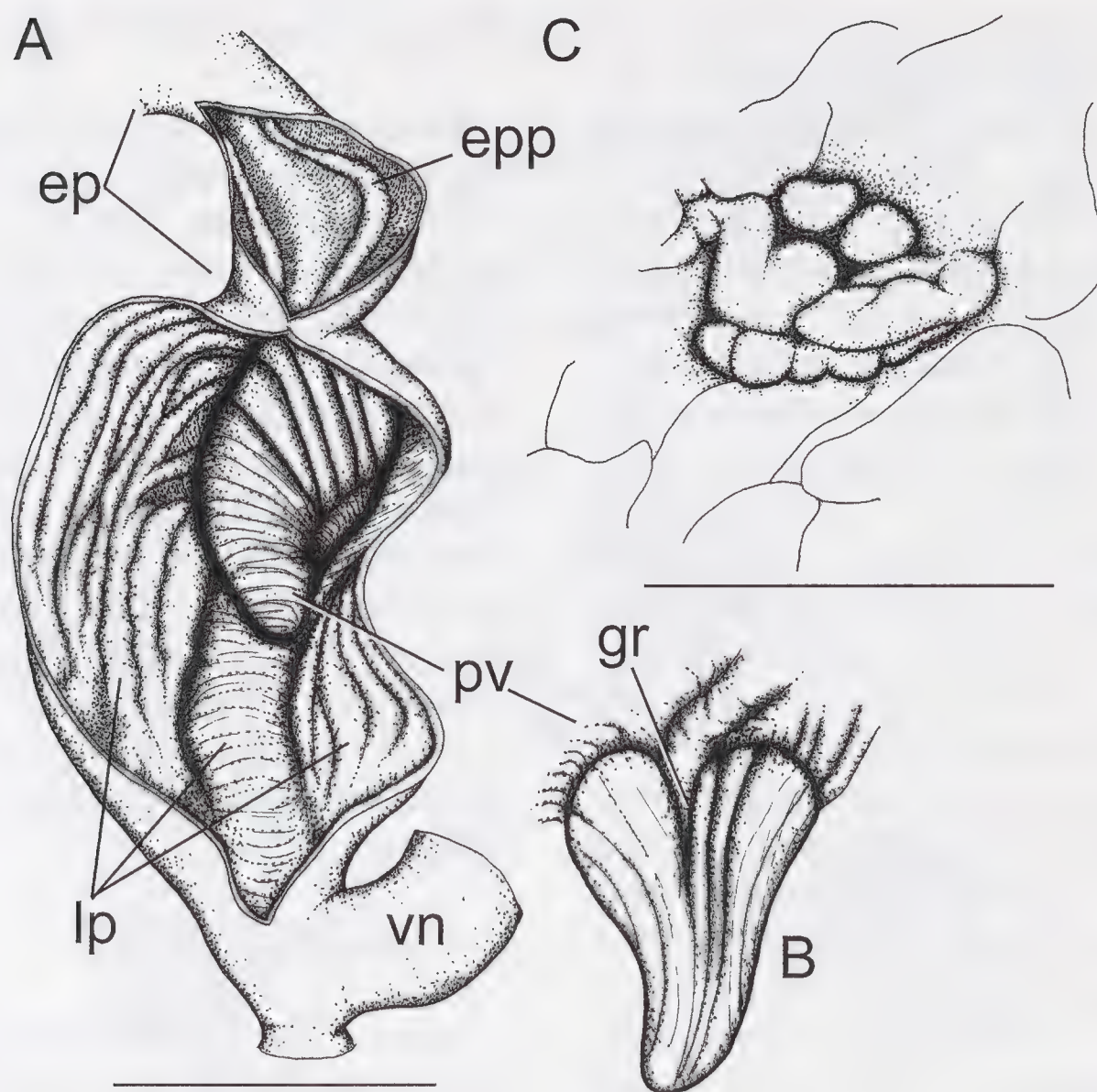


FIG. 88. Penial anatomy and head wart of *Rhagada felicitas* n. sp. holotype WAM S58487 (Storr Island, May). A: Penial anatomy; B: Magnification of backside of penial verge; C: Head wart. Scale bars = 1 mm.

Rhagada cygna Solem, 1997
Figs. 79E–F, 89–90

Rhagada cygna Solem, 1997: 1785–1789,
pl. 210e–f, 226a–f, figs. 429d–f, 431a, b,
432a–c.

Type Locality

Western Australia, southwestern Kimberley,
northern tip of Dampier Peninsula, Cygnet Bay,
Pearl Fisheries, One Arm Point, 16°27'13"S,
123°02'40"E.

Material Examined

AM C463537 (preserved specimens) from
Gambanan, NW One Arm Point, Dampier Penin-
sula; AM C463559 (preserved specimens) from
Bully's Camp, Cygnet Bay, Dampier Peninsula;
AM C463564 (preserved specimens) from Skel-
eton Point, Dampier Peninsula; WAM S37739
(5 preserved specimens), WAM S49233 (4
preserved specimens), AM C471877 (2 shells),
WAM S37831 (7 shells) from Old Mission area,
central part of Sunday Island, 16°24'47"S,
123°10'45.5"E; WAM S49231 (8 preserved

specimens), AM C471878 (4 preserved speci-
mens) from eastern section of Sunday Island,
16°25'20"S, 123°12'45"E; WAM S49232 (10
preserved specimens), from southern section
of Sunday Island, 16°25'55"S, 123°11'28"E;
WAM S37728 (preserved specimen, dissected),
AM C471879 (10 preserved specimens), WAM
S49236 (25 preserved specimens) from Buc-
caneer Archipelago, northwestern section of
Hidden Island, 16°13'29"S, 123°26'51"E and
16°12'50.5"S, 123°27'31.8"E.

Diagnosis

Shell: Small to medium sized ($D = 10\text{--}14$ mm;
Table 5), thin but solid, broadly conical with mod-
erately elevated spire with 4.4–5.4 whorls and
strongly elevated apex; periphery of last whorl
well rounded to slightly depressed (Fig. 79E,
F). Protoconch nearly smooth (comprising less
than a whorl followed by sharp transition to te-
leoconch; Fig. 89A, D). Teleoconch with growth
pauses and prominent radial ridglets (Fig. 89B,
C, E, F). Umbilicus closed in 2/3 of adults,
narrowly open in 1/3 of adults; background
white, with reddish brown suffusion on spire,
supra-peripheral band usually well developed,

moderately thick, distinct, visible on all to most whorls; subsutural band varies from thin to absent, additional spiral bands thinner and lighter in colour, usually diffuse, reddish brown colour, varying in number from one to two above, nil to five below supra-peripheral band; inner and outer lip colour white. Last whorl descending slightly behind thin, moderately expanded lip.

Genital anatomy and head wart: Penis moderately long, with slightly inflated proper and coiled epiphallus; epiphallic flagellum rather long; penial wall thick proximally, thin distally, interiorly with weak but regular longitudinal folds comprising almost entire length of inner wall, giving rise to well-developed, laterally corrugated pilasters at proximal end; epiphallic wall thick, with indistinct transverse folds or lamellae but no prominent pilasters; penial verge large, extending about half of penial lumen, broadly ovate, smooth, with small, pointed tip; sperm groove stopping well short of tip, long, curved, bounded by thickened margin (Fig. 90A, B). Bursa copulatrix long, kinked. Head wart small, circular (Fig. 90C).

Mitochondrial Differentiation

Sixteen specimens sequenced (eleven from Dampier Peninsula, one from Sunday Island, four from Hidden Island); overall infraspecific genetic distances 0.0–0.05; genetic distances within and between populations from Dampier Peninsula and Sunday Island: 0.012–0.034; on Hidden Island two distinct haplotype groups were found, one being more similar to mainland haplotypes (distances: 0.034–0.045) than to other sequences from the island (0.041–0.047), three other haplotypes from Hidden Island differ from mainland haplotypes by 0.032–0.043 (1 sequence). Interspecific genetic distances: 0.13–0.14 with respect to *R. dominica* and *R. primigena*, and 0.21–0.22 to all other congeners.

Comparative Remarks

Genetic distances between local populations are considerable: up to 0.034 between populations on Dampier Peninsula and 0.03–0.05

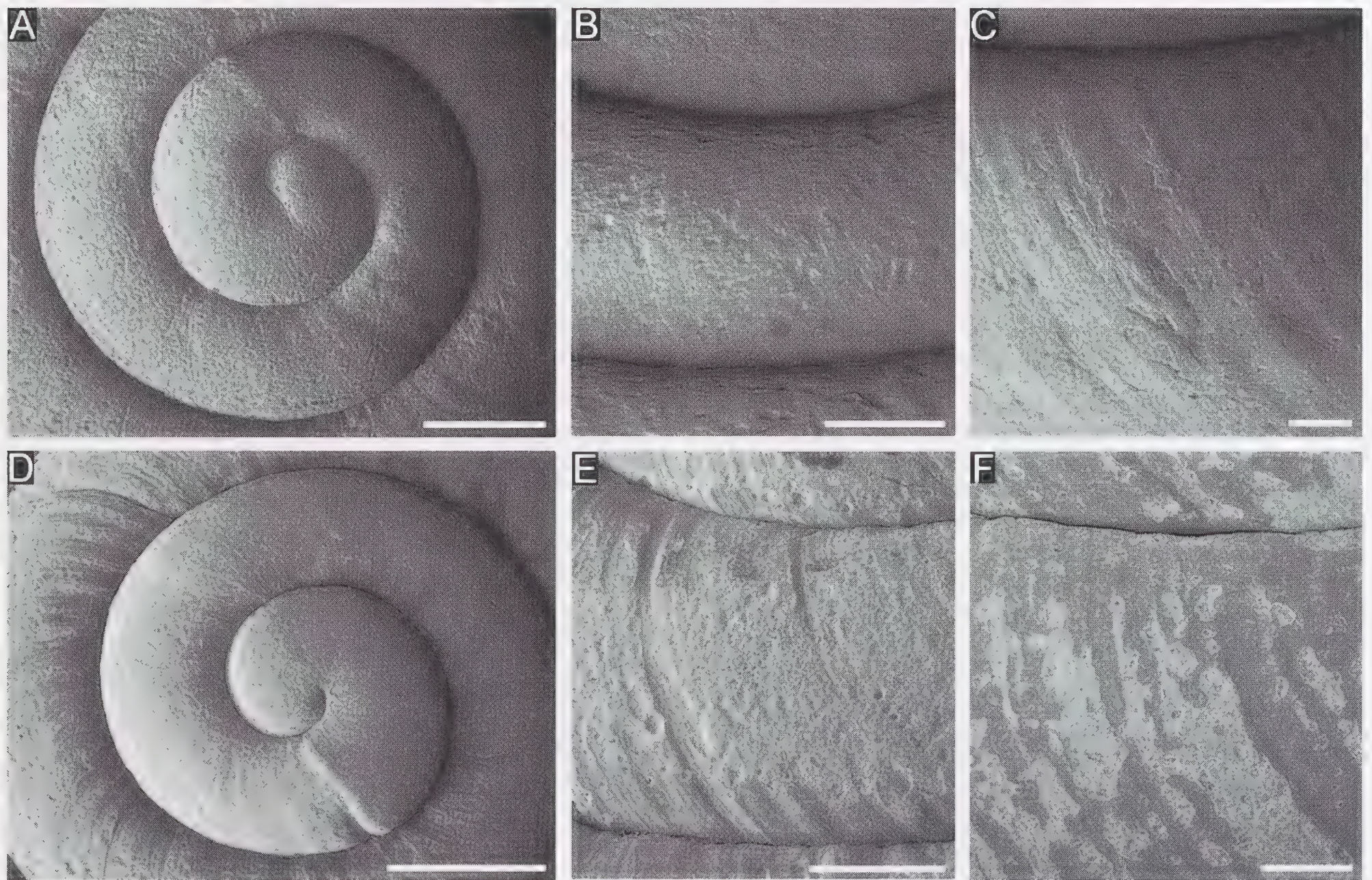


FIG. 89. SEM micrographs of shells of *Rhagada* species. A–C: *Rhagada* cf. *cygna* AM C 471879 (Hidden Island). A: Apical view showing protoconch; B: Close-up of sculpture on second to third whorl; C: Close-up of sculpture on last whorl; D–F: *Rhagada cygna* AM C 471877 (Sunday Island). D: Apical view showing protoconch; E: Close-up of sculpture on second to third whorl; F: Close-up of sculpture on last whorl. Scale bars A, D = 1 mm; B–C, E–F = 500 μ m.

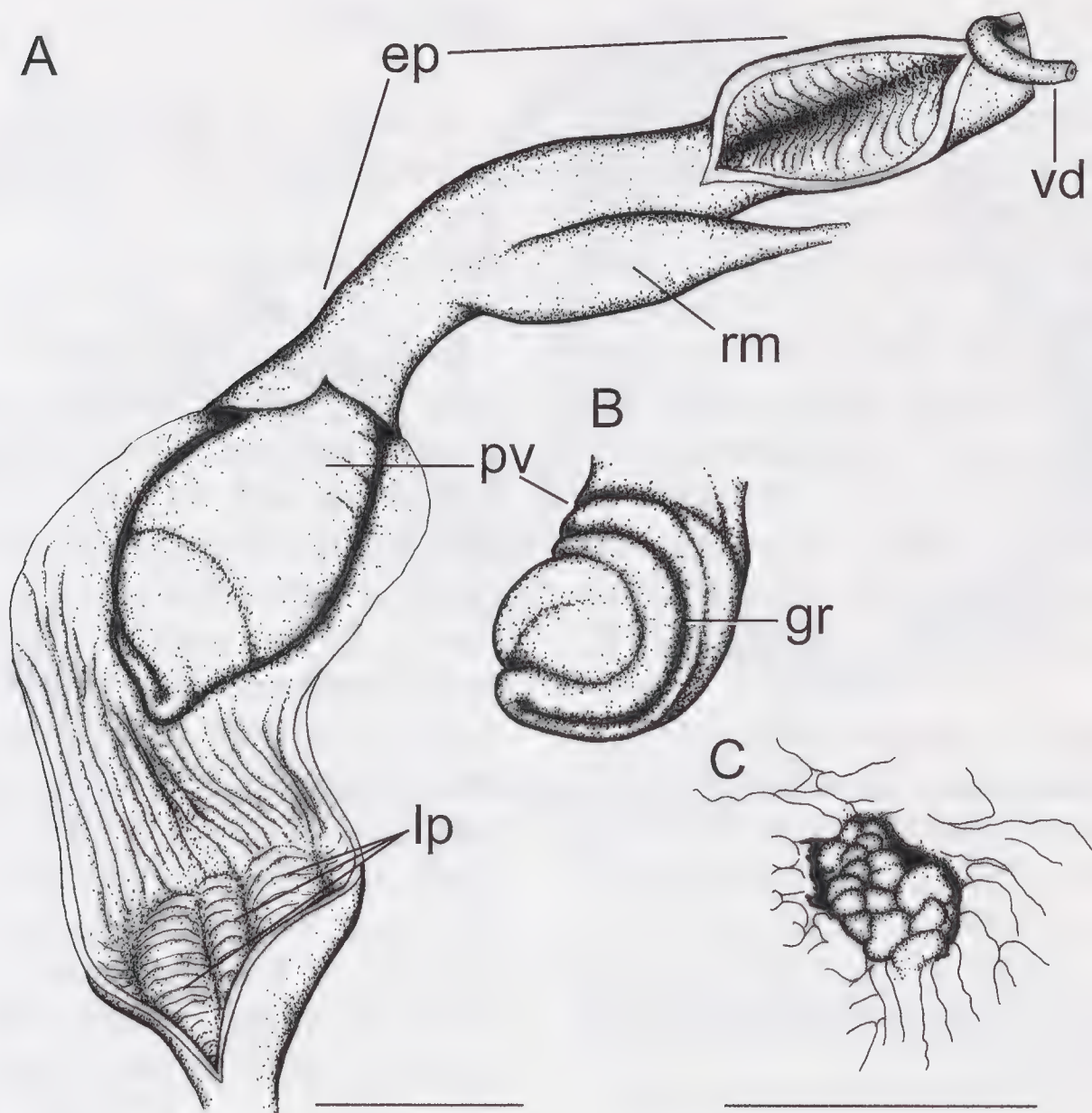


FIG. 90. Penial anatomy and head wart of *Rhagada* cf. *cygna* WAM S37728 (Hidden Island, June). For comparison with anatomy of type material from the Dampier Peninsula compare with Solem (1997: 1788, fig. 432). Scale bars = 1 mm.

between populations from different islands. There is no correlation between genetic and geographic distances. Hidden Island supports two genetically distinct haplotype groups, which indicates more than one past event of over-water dispersal. These haplotypes are nested within the mainland clade. Local genetic differentiation of island and mainland populations is considered to be at the infraspecific level. Morphological differences between local populations are subtle. Anatomy of *R. cygna* from Dampier Peninsula was figured by Solem (1997). Penial anatomy of a specimen from Hidden Island as shown herein in Figure 90 essentially differs by a more rounded tip of verge and more pronounced penial wall sculpture. From other species, *R. cygna* is differentiated by genetic distances of 0.13–0.24. *Rhagada dominica* occurring in sympatry on Sunday Island, differs most conspicuously by its larger shell. *Rhagada primigena* differs by its on average larger and flatter shell, presence of well-developed epiphallic pilasters and a more elongated penial verge. In most camaenids, including most *Rhagada* species, transition from protoconch to teleoconch shell

is not well marked and mostly the protoconch comprises 1.5–2 whorls. The two shells of *R. cygna*, however, reveal a sharp transition between protoconch and teleoconch with the protoconch having only 0.7 whorls.

Distribution (Fig. 78)

Previously known from northern tip of Dampier Peninsula, Cygnet Bay and One Arm Point, only. Here reported from Sunday Island, about 12 km E of One Arm Point, where it is found in sympatry with *R. dominica* n. sp., as well as from Hidden Island, King Sound.

Rhagada dominica n. sp.

Figs. 79G, 91A–C, 92, 93

Type Locality

Western Australia, southwestern Kimberley, Buccaneer Archipelago, King Sound, Old Mission area, central part of Sunday Island, 16°24'47"S, 123°10'45.5"E; coll. Frank Köhler, 06/06/2009, KIS 1–81 (open woodland, grassland, aestivating under rocks).

Material Examined

Holotype WAM S58488 (preserved specimen, Fig. 79G). Paratypes AM C471874 (10 preserved specimens), WAM S37702 (25 preserved specimens), WAM S49235 (15 preserved specimens), AM C471876 (4 shells), WAM S37813 (8 shells) from type locality; WAM S37698 (25 preserved specimens), AM C471875 (7 preserved specimens) from southern section of Sunday Island, 16°25'30"S, 123°10'30"E; WAM S37699 (13 preserved specimens), WAM S37810 (6 shells) from northern tip of Sunday Island, 16°23'28.1"S, 123°10'32.4"E.

Additional, non-type material WAM S37701 (10 preserved specimens), WAM S37811 (7 shells) from southern section, 16°25'37"S, 123°10'35"E; WAM S37701 (10 preserved specimens), WAM S37813 (12 shells) from southern section, 16°25'11"S, 123°10'35"E; WAM S49234 (15 preserved specimens) from 16°25'31"S, 123°10'30"E.

Etymology

In reference to the Italian word for Sunday ("domenica"); noun in apposition.

Description

Shell (Figs. 79G, 91A–C, Table 5): Medium size (large compared to other species), solid, broadly conical with moderately elevated spire; periphery well rounded to slightly angulated; last whorl well rounded above and below periphery; umbilicus closed; background colour rarely white, mostly yellowish to brownish horn; supra-peripheral band varying in development, usually well developed, rather thin to moderately thick, distinct, visible on all to most whorls; subsutural band varies from absent to thick, additional spiral bands thinner and lighter in colour, varying in number from one to three above, nil to seven below supra-peripheral band, in development from diffuse to distinct; inner lip colour white to horn. Protoconch ~ 3.1

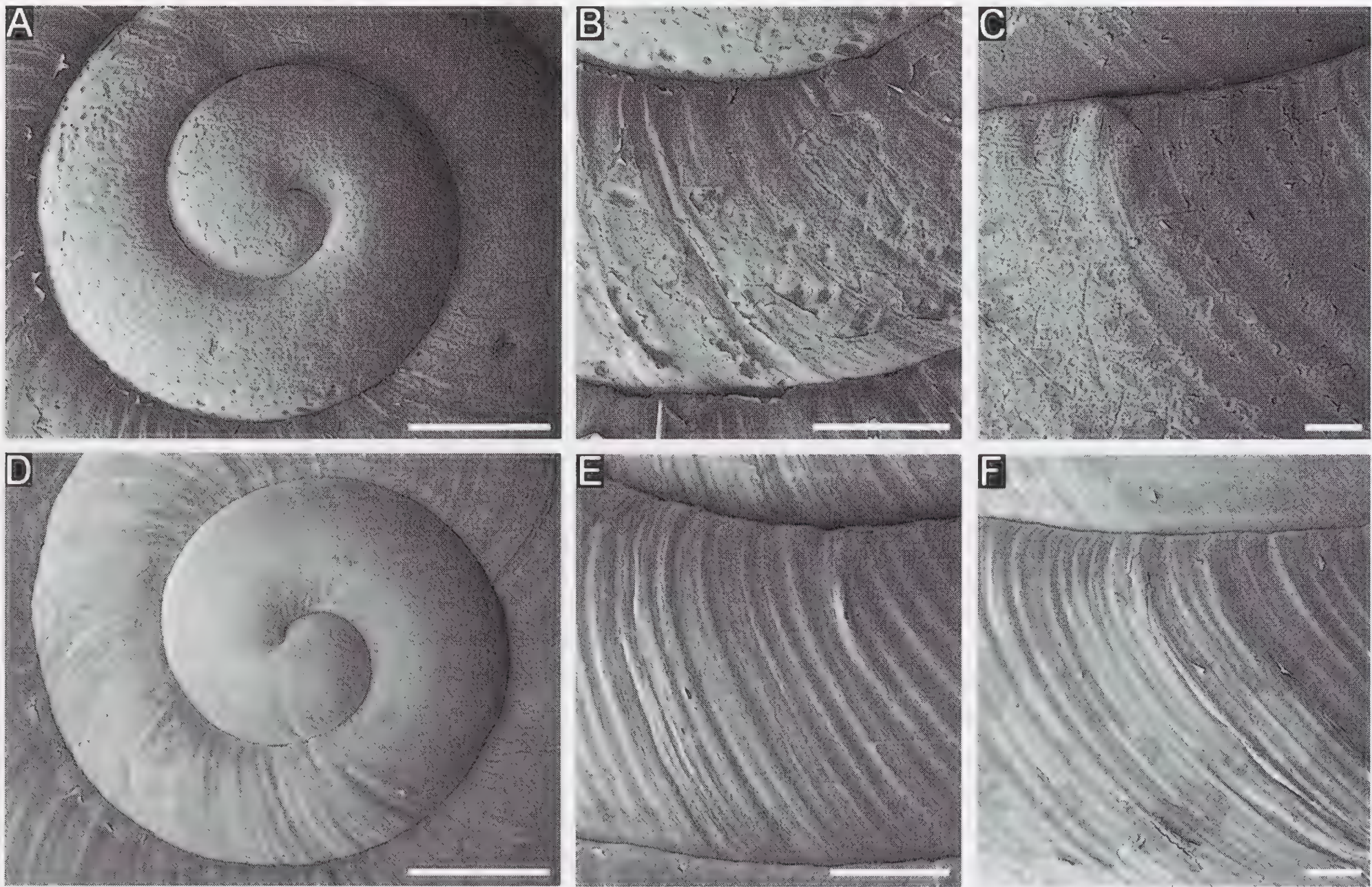


FIG. 91. SEM micrographs of shells of *Rhagada* species. A–C: *Rhagada dominica* paratype AM C471876 (Sunday Island). A: Apical view showing protoconch; B: Close-up of sculpture on second to third whorl; C: Close-up of sculpture on last whorl; D–F: *Rhagada primigena* paratype AM C471872 (Long Island). D: Apical view showing protoconch; E: Close-up of sculpture on second to third whorl; F: Close-up of sculpture on last whorl. Scale bars A, D = 1 mm; B–C, E–F = 500 μ m.

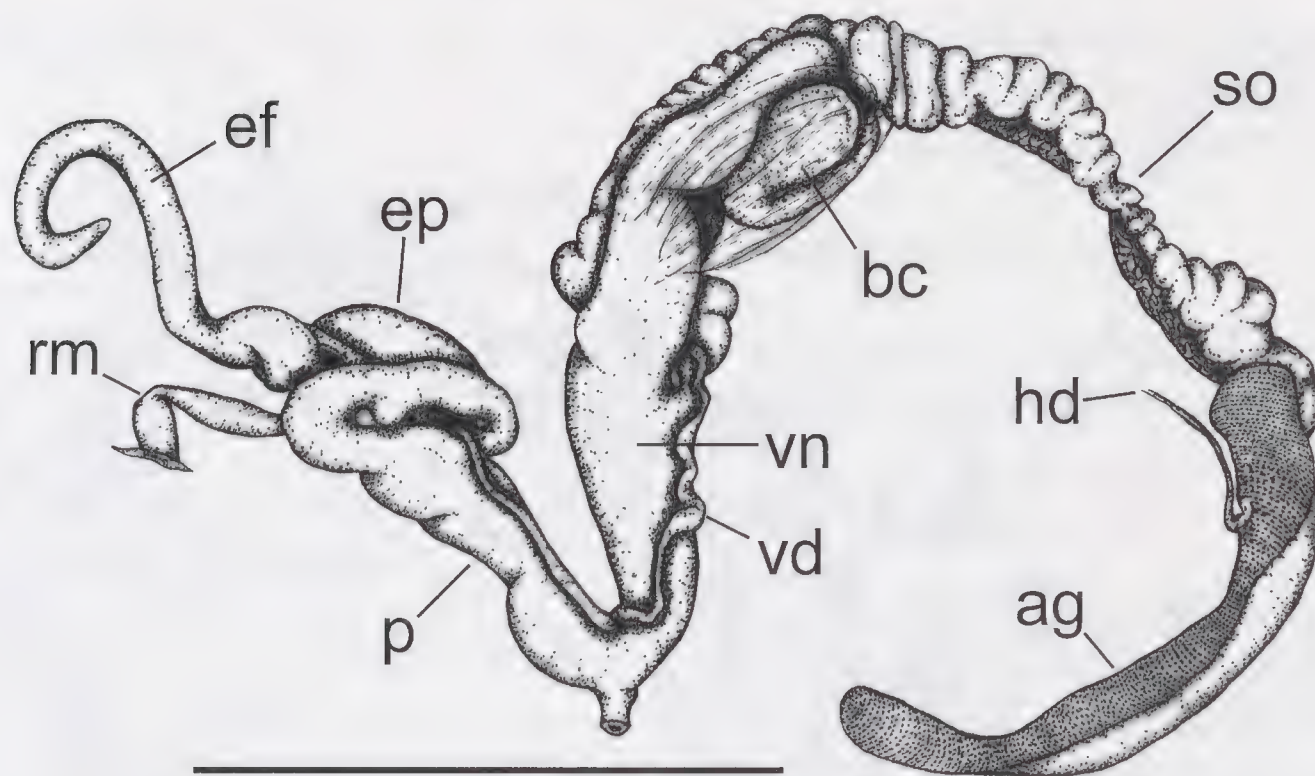


FIG. 92. Genital anatomy of *Rhagada dominica* n. sp. paratype AM C471874 (Sunday Island, June). Scale bar = 10 mm.

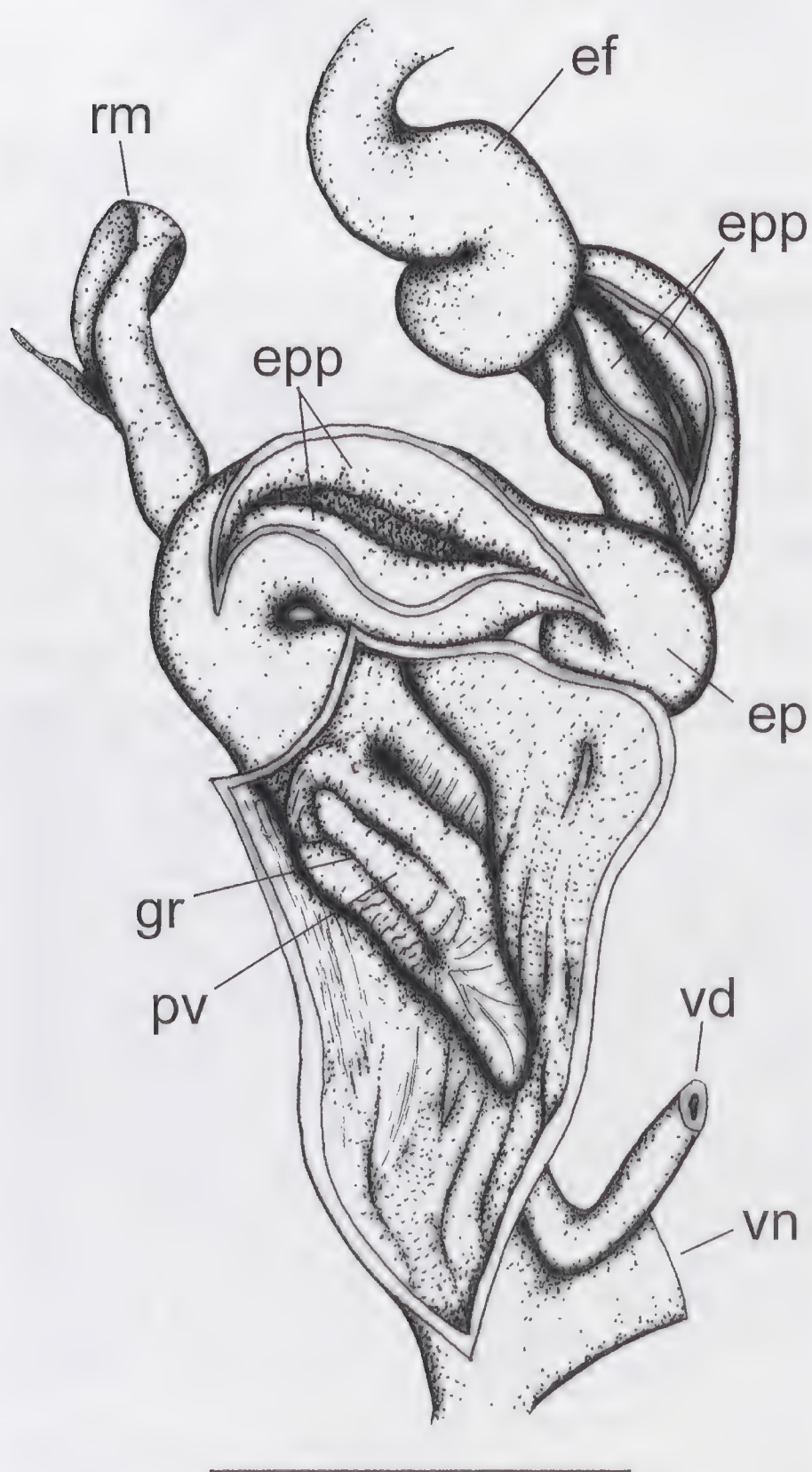


FIG. 93. Penial anatomy and head wart of *Rhagada dominica* n. sp. paratype AM C471874 (Sunday Island, June). Scale bar = 3 mm.

mm in diameter, with ~ 1.8 whorls, smooth. Teleoconch smooth with faint radial growth lines. Angle of aperture ~ 45°; last whorl abruptly descending behind lip; outer lip rounded, sharp to thin, slightly expanded, basal node of lip weak, palatal node absent.

Genital anatomy (Figs. 92–93): Penis moderately long, with slightly inflated proper and coiled, long epiphallus; epiphallic flagellum rather long; penial wall thick, interiorly with weak, irregular longitudinal folds comprising proximal part of inner wall; epiphallic wall with two well-developed longitudinal pilasters; penial verge large, conical, pointed extending about half of penial lumen, smooth; sperm groove stopping well short of tip, long, straight. Bursa copulatrix long, kinked.

Mitochondrial Differentiation

Three specimens sequenced; infraspecific genetic distances 0.00–0.02; interspecific genetic distances: 0.03–0.04 with respect to *R. primigena*, 0.13–0.14 with respect to *R. cygna* and 0.20–0.21 to all other congeners.

Comparative Remarks

Genetic distances of more than 13% supporting distinct status with respect to other species except *R. primigena*, which is not well differentiated by means of genetic distances. However, the latter differs significantly by a smaller size and flatter shape (Table 5). Therefore, it is considered as distinct species despite the low genetic distances.

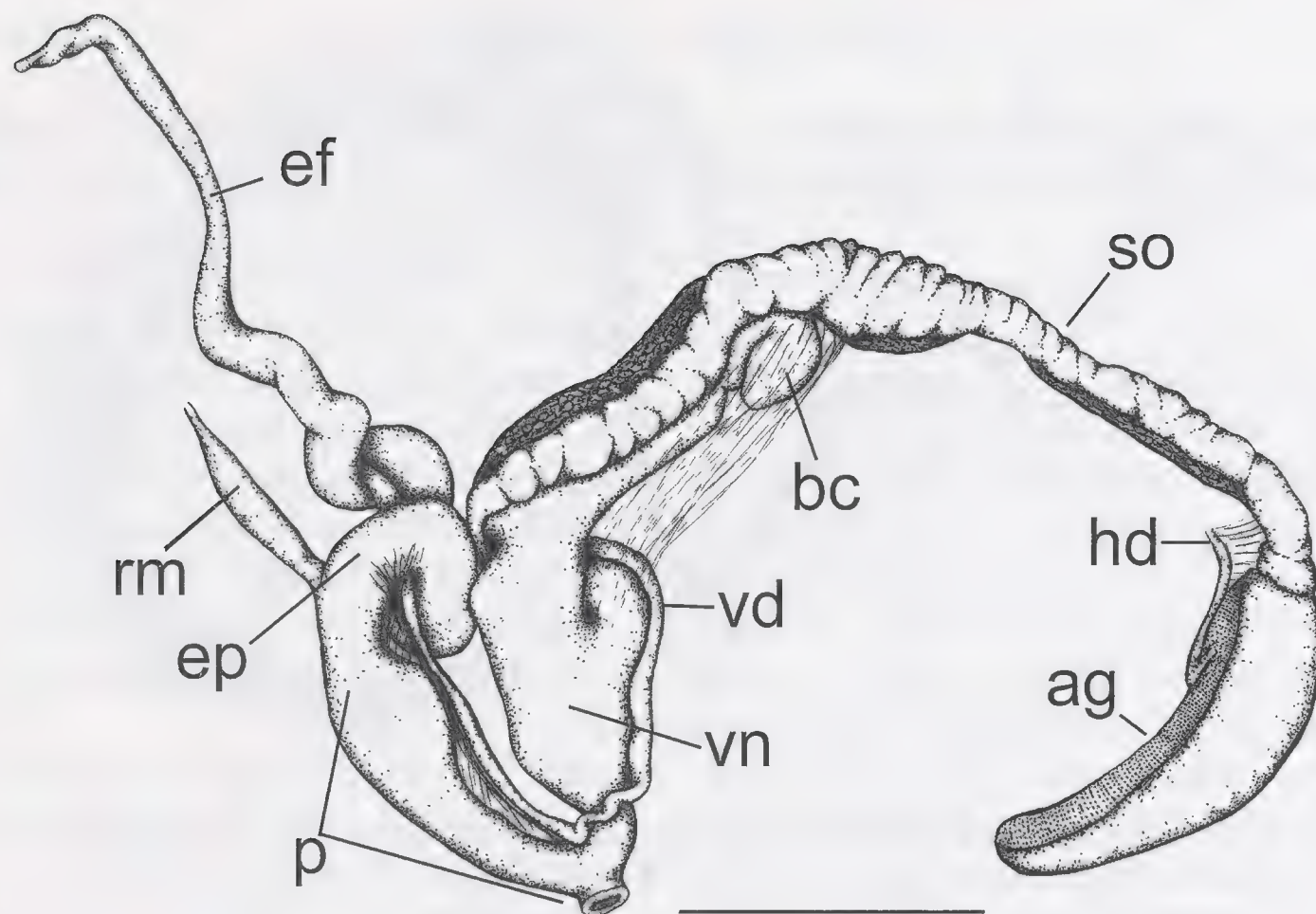


FIG. 94. Genital anatomy of *Rhagada primigena* n. sp. paratype AM C471871 (Long Island, May). Scale bar = 3 mm.

Distribution (Fig. 78)

Known from Sunday Island only, where it occurs in sympatry with *R. cygna*; not found on adjacent Dampier Peninsula or other islands.

***Rhagada primigena* n. sp.**
Figs. 79H–I, 92D–F, 94, 95

Type Locality

Western Australia, southwestern Kimberley; Buccaneer Archipelago, King Sound, NE section of Long Island, 16°33'34"S, 123°21'49"E (coll. Frank Köhler, 1/06/2009, KIS 1–76 (gully with dense vegetation, partly overgrown with *Passiflora*; under rocks).

Material Examined

Holotype WAM S37721 (preserved specimen, Fig. 79H). Paratypes AM C471871 (20 preserved specimens), WAM S37719 (31 preserved specimens), WAM S49229 (63 preserved specimens), AM C471872 (6 shells), WAM S37829 (14 shells) from type locality; WAM S37720 (2 preserved specimens), WAM S37721 (preserved specimen), WAM S37830 (3 shells) from 16°33'34–43"S, 123°21'24–49"E.

Additional, non-type material. AM C471873 (4 preserved specimens), WAM S49230 (10 preserved specimens) from largest unnamed island in Fairway Islands Group, West

of Long Island, King Sound, 16°34'26.6"S, 123°19'11.2"E.

Etymology

From "*primigenus*" (Latin, masculine = first of all), because this was the first species that I collected myself in the Kimberley; adjective of feminine gender.

Description

Shell (Figs. 79H, I, 91D–F, Table 5): Small to medium sized, thin but solid, broadly conical with low to moderately elevated spire; slightly angulated periphery; last whorl well rounded above and below periphery; umbilicus closed in 80%, narrowly open in 20% of adults; background white to whitish horn, almost completely covered by reddish brown suffusion of spiral bands; supra-peripheral band usually well developed, rather thin to moderately thick, distinct, visible on all to most whorls; subsutural band varies from thin to moderately thick, additional spiral bands thinner and lighter in colour, usually diffuse, blending into each other giving the shell a predominantly reddish brown colour, varying in number from one to three above, nil to many below supra-peripheral band, in development from diffuse to distinct; base of shell with glossy surface, lighter in colour than rest of shell; lip distinctly white. Protoconch ~ 2.4 mm in diameter, with ~ 0.8 whorls, smooth.

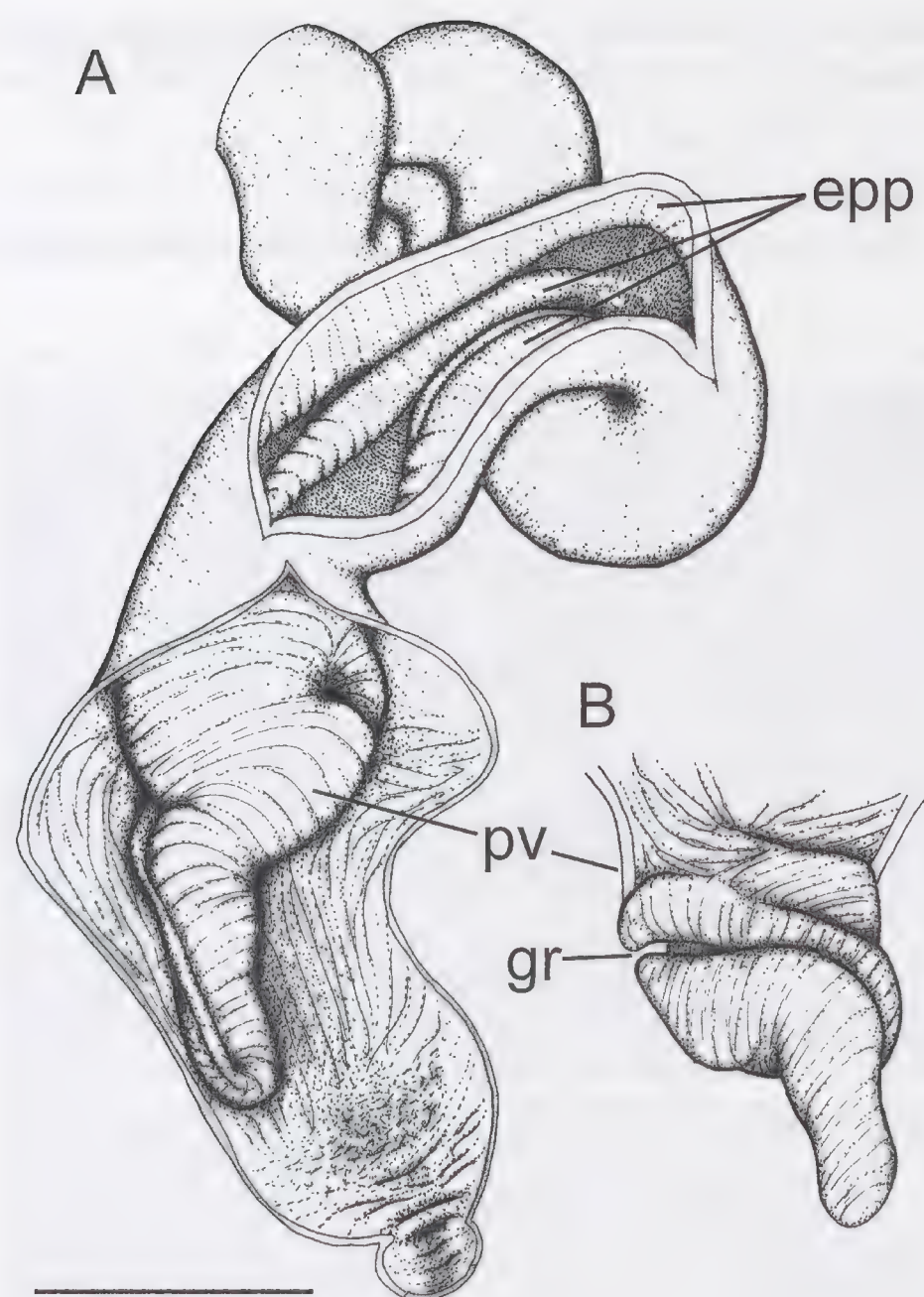


FIG. 95. Penial anatomy of *Rhagada primigena* n. sp. paratype AM C471871 (Long Island, May). A: Penial anatomy. Scale bar = 1 mm; B: Magnification of backside of penial verge.

Teleoconch smooth with faint radial growth lines. Angle of aperture $\sim 45^\circ$; last whorl weakly descending behind lip; outer lip rounded, relatively thick, slightly expanded, basal node of lip weak, palatal node absent.

Genital anatomy (Figs. 94–95): Penis moderately long, with slightly inflated proper and coiled epiphallus; epiphallic flagellum extremely long; penial wall thick proximally, thin distally, interiorly with weak longitudinal folds comprising proximal part of inner wall; epiphallic wall with three well-developed longitudinal pilasters; penial verge large, conical, with elongate-pointed tip, extending more than half of penial lumen, with faint transverse corrugations; sperm groove almost reaching tip, very long, winding, bounded by thickened margins. Vagina short, inflated. Bursa copulatrix long, kinked.

Mitochondrial Differentiation

Five specimens sequenced (three from Long Island, two from Fairway island group); infraspecific distance: 0.00–0.01; interspecific

genetic distances: 0.03–0.04 with respect to *R. dominica*, 0.13–0.14 with respect to *R. cygna* and 0.21–0.24 to all other congeners.

Distribution (Fig. 78)

Known from Long Island and Fairway Islands about 6 km W of Long Island, King Sound.

Comparison

Typical combination of features are small size of shell, predominantly reddish brown colouration, glossy base of shell, distinctly white outer and inner lip of shell in contrast with rest of shell. Like *R. cygna*, this species differs from other congeners by smaller protoconch with fewer whorls (< 1 instead of 1.5–2); differs from *R. cygna* by larger shell (Table 5), pointed verge and well-developed epiphallic pilasters.

Retroterra Solem, 1985

Retroterra Solem, 1985a: 787–804; 1991: 209–210; Solem & McKenzie, 1991: 247–263. Type species: *Retroterra costa* Solem, 1985, by original designation.

Diagnosis

Shell: Medium sized to large ($D = 13$ – 23 mm; Table 6), thin to moderately thick, discoidal with flat to low spire; umbilicus moderately to widely open (outer diameter > 8 mm), not concealed; protoconch sculpture from rather smooth to consisting of weak to well-developed, radially elongated pustulation; teleococonch with fine to very prominent, narrowly spaced radial ribs, sometimes anastomosing; no significant microsculpture; whorls moderately to rapidly increasing; deep suture; periphery well rounded. Shell colour more or less uniform except for lighter base, yellowish brown to dark brown; no banding.

Genital anatomy: Penis without penial sheath, with well-developed, long and coiled epiphallus supporting epiphallic flagellum of variable length. Penial retractor muscle attached at epiphallus. Epiphallus opens to penial lumen through verge. Vas deferens entering epiphallus laterally at base of flagellum. Bursa copulatrix very long, complexly kinked or coiled.

Aestivation Strategy

Free sealer.

TABLE 6. Shell parameters of *Retroterra* (in mm), given are maximum – minimum (mean $\pm$ standard deviation) for N measured specimens. Abbreviations used: HT = holotype; * from Prince Regent Reserve, WAM S49570.

Species	N	Height (H)	Diameter (D)	Umbilical Width	Whorls	H/D Ratio
<i>R. aequabilis</i> n. sp.	HT	13.0	21.8	6.2	4.7	0.60
	6	10.5–13.0 (11.9 $\pm$ 1.0)	17.7–23.5 (19.8 $\pm$ 2.0)	5.2–8.0 (6.1 $\pm$ 0.9)	4.2–5.1 (4.6 $\pm$ 0.3)	0.55–0.64 (0.59 $\pm$ 0.03)
<i>R. solituda</i> Solem, 1985*	9	10.4–13.0 (11.9 $\pm$ 0.9)	20.1–23.6 (22.1 $\pm$ 1.2)	5.2–6.5 (5.8 $\pm$ 0.4)	4.2–4.9 (4.6 $\pm$ 0.2)	0.47–0.57 (0.54 $\pm$ 0.03)
<i>R. discoidea</i> n. sp.	HT	6.1	18.6	6.1	3.8	0.33
	14	5.5–7.3 (6.5 $\pm$ 0.6)	14.5–18.6 (17.5 $\pm$ 1.1)	4.0–6.2 (5.6 $\pm$ 0.5)	3.5–4.0 (3.7 $\pm$ 0.2)	0.32–0.50 (0.37 $\pm$ 0.05)
<i>R. acutocostata</i> n. sp.	HT	6.5	13.6	4.3	3.3	0.48
	5	5.8–7.1 (6.3 $\pm$ 0.4)	13.6–17.3 (15.4 $\pm$ 1.2)	4.3–5.7 (4.9 $\pm$ 0.4)	3.3–3.6 (3.5 $\pm$ 0.1)	0.37–0.48 (0.41 $\pm$ 0.04)

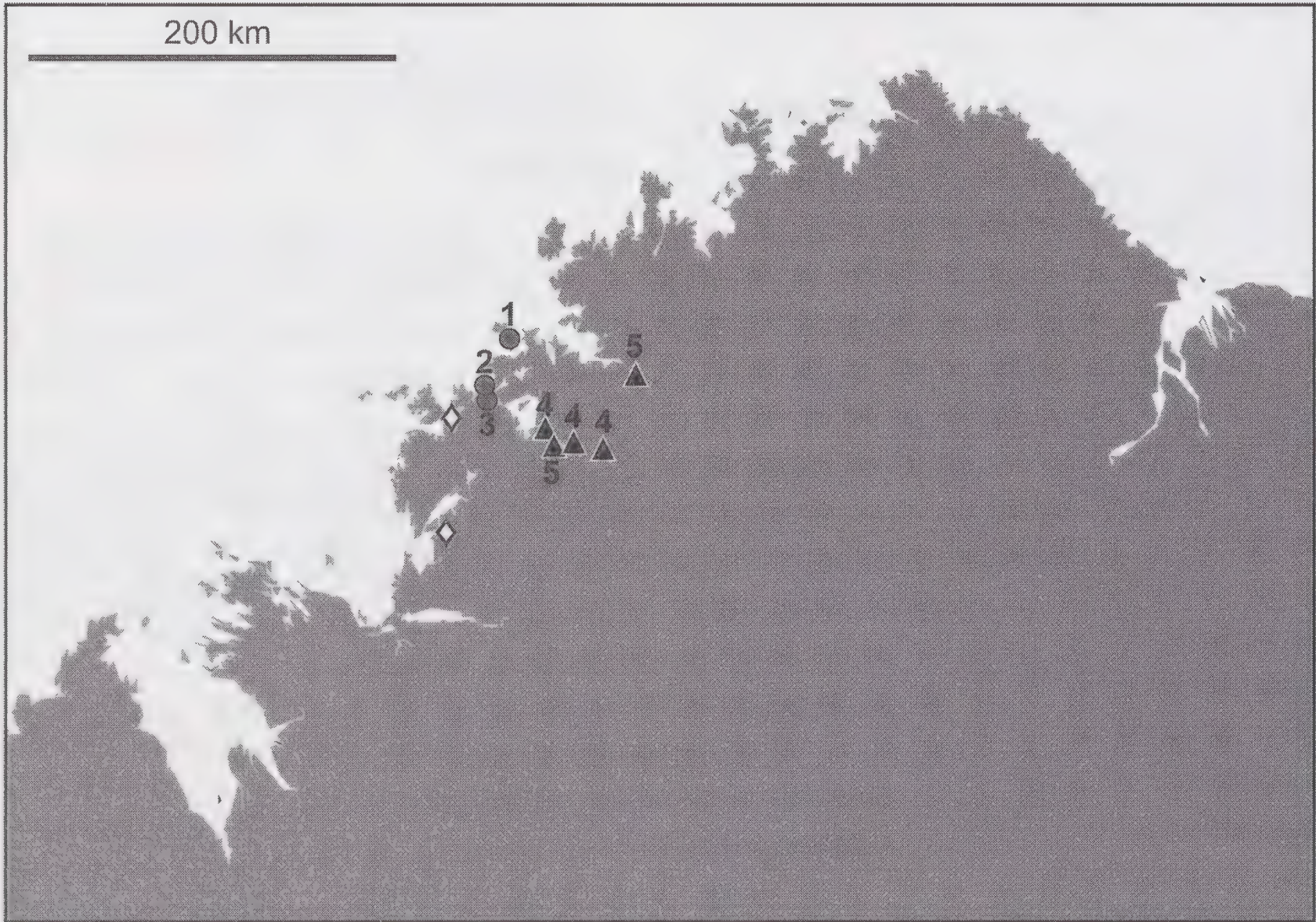


FIG. 96. Distribution map of *Retroterra*. Circles = records of species treated herein: 1: *R. aequabilis* n. sp. (Boongaree Island), 2: *R. discoidea* n. sp. (Uwins Island), 3: *R. acutocostata* n. sp. (Halfway Bay); triangles = records of Solem (1985): 4: *R. solituda* (Prince Regent Reserve), 5: *R. parva* Solem, 1985 (mainland); diamonds = records of undescribed taxa listed by Solem (1991).

Comparative Remarks

The rather large, discoidal shell with wide umbilicus and ribbed sculpture set this taxon apart from all other Kimberley camaenids.

Retroterra differs from its supposed relative *Baudinella* by larger size, absence of microsculpture, conspicuous ribbing, and weaker expansion of lip. It differs from *Setobaudinia* most conspicuously by ribbing of shell, and

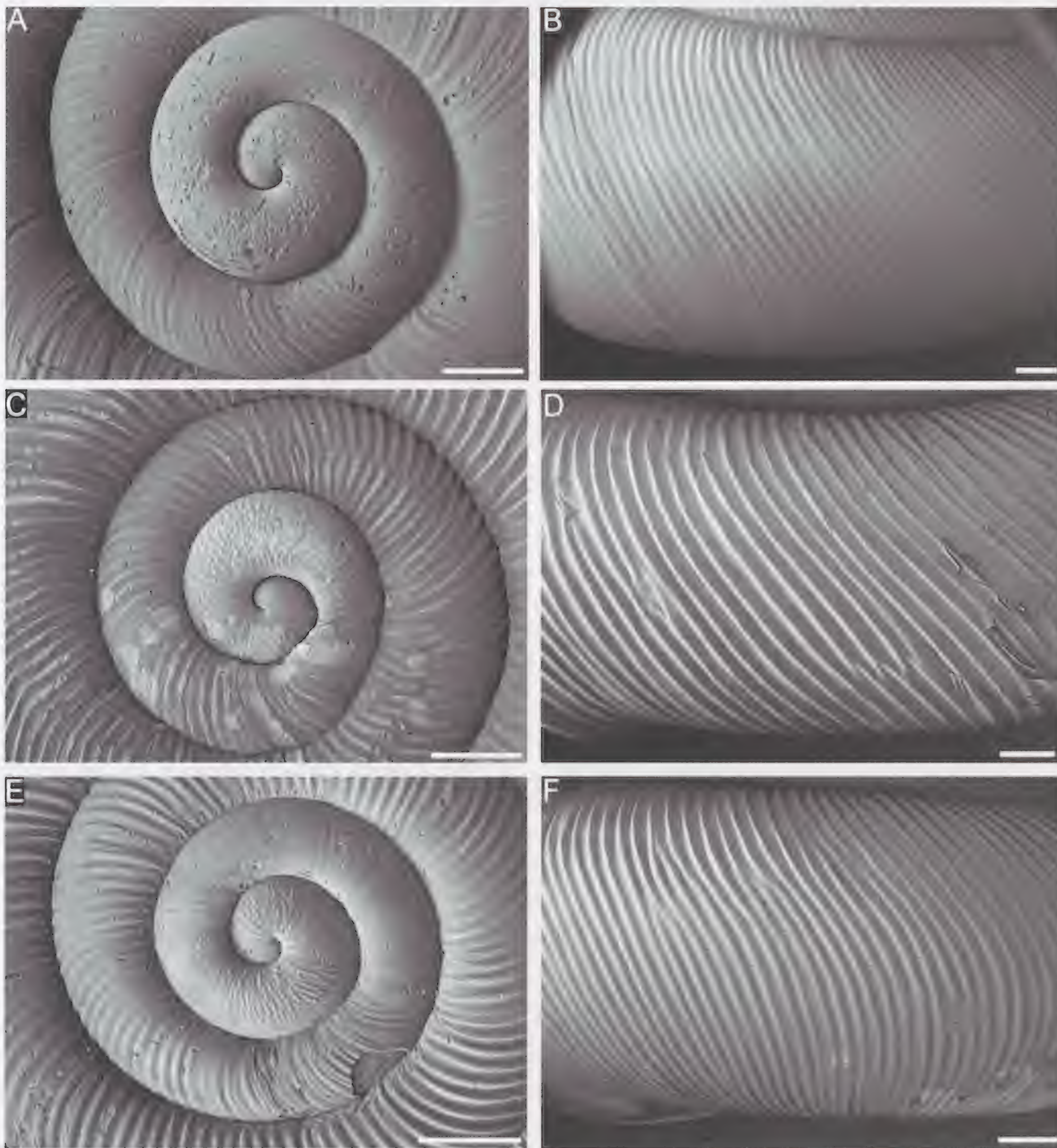


FIG. 97. SEM micrographs of shells of *Retroterra* species. A–B: *Retroterra aequabilis* n. sp. paratype WAM S49014 (Boongaree Island). A: Apical view showing protoconch and first whorl; B: Close-up of sculpture on last whorl, lateral view; C–D: *Retroterra discoidea* n. sp. paratype WAM S49036 (Uwins Island). C: Apical view showing protoconch and first whorl; D: Close-up of sculpture on last whorl, lateral view; E–F: *Retroterra acutocostata* n. sp. paratype AM C471756 (Boongaree Island). E: Apical view showing protoconch and first whorl; F: Close-up of sculpture on last whorl, lateral view. Scale bars = 1 mm.

from *Torresitrachia* by widely open umbilicus; see also Solem (1985a).

Diversity and Distribution (Fig. 96)

Three described and two unnamed species were reported from the Prince Regent Reserve by Solem (1985a, 1991), who pointed out that *Retroterra* seems to be absent from most islands in the Admiralty Gulf and the Mitchell Plateau. Occurrence further south has remained unclear. Here species are reported from Boongaree and Uwins islands, respectively as well as from Hanover Bay area, which fall right within the range circumscribed by Solem (1985a).

Retroterra aequabilis n. sp. Figs. 79J, 97A, B

Type Locality

Western Australia, central Kimberley coast, Bonaparte Archipelago, central section of Boongaree Island, 15°04'30"S, 125°11'21"E; coll. Vince Kessner, 07/02/2009, KIS 1–64 (vine thicket/rainforest on steep upper slopes, in deep leaf litter amongst boulders).

Material Examined

Holotype WAM S58448 (preserved specimen; Fig. 79J), paratypes WAM S37629 (5 preserved specimens), WAM S49015 (shell) from type locality; WAM S36439 (3 shells) from 15°04'36"S, 125°11'12"E; WAM S36440 (shell) from 15°04'15"S, 125°11'14"E; WAM S37628 (preserved juvenile) from 15°03'28"S, 125°10'29"E; WAM S49014 (shell) from 15°03'28"S, 125°10'29"E.

Etymology

From "*aequabilis*" (Latin = similar or equal to), for close similarity with *Retroterra solituda* Solem, 1985, from Prince Regent Reserve; adjective of feminine gender.

Description

Shell (Figs. 79J, 97A, B): Medium to large (D ~ 23 mm on average in fully grown adults; Table 6), with weakly elevated spire and not or weakly descending body whorl. Umbilicus 5–8

mm wide. Protoconch rather smooth (Fig. 97A), extending more than one whorl. Teleoconch with regular, fine, narrowly spaced radial ribs, not extending onto base of shell and into umbilicus (Fig. 97B). Periphery of last whorl well rounded, separated by rather shallow suture. Shell uniformly dark brown with much lighter, yellowish brown base. Lip of aperture weakly expanded, simple, parietal wall thinly callused.

Mitochondrial Differentiation

Interspecific genetic distances (1 sequence): 0.089 with respect to *R. solituda* from the type locality of this species (2 sequences), 0.105 to *R. discoidea* (1 sequence), and 0.113 to *R. acutocostata* (1 sequence).

Comparative Remarks

Genital anatomy remaining unknown for poor preservation or juvenile status of types. Very similar to *R. solituda* Solem, 1985, from Youwanjela Creek, Prince Regent Reserve, Kimberley mainland. Only few worn and poorly preserved specimens are available from Boongaree Island, about 65 km in northwesterly direction from type locality of *R. solituda*, which differs from all other species most conspicuously by larger size and weaker ribs. The decay of examined specimens of *R. aequabilis* does not allow for documentation of genital anatomy. Compared with *R. solituda* (topotypes, WAM S49570), *R. aequabilis* exhibits subtle differences in shell morphology that per se would not justify recognition as distinct: a generally lighter shell colour, a more indistinct demarcation of the lighter colour field at base of shell, less marked contrast between shell and base colour, a comparatively wider umbilicus (average U/D ratio 3.16 in *R. aequabilis*, 3.34 in *R. solituda*), smaller average diameter at same shell height (Table 6), and wider cross-section of body whorl, which tends to be more keeled in *R. solituda*. However, molecular phylogenetic data strongly supports treatment as distinct species because in preliminary phylogenetic trees both are shown as two well-differentiated clades, and not in a sister-group relationship (Köhler, unpubl. data).

Distribution (Fig. 96)

Boongaree Island.

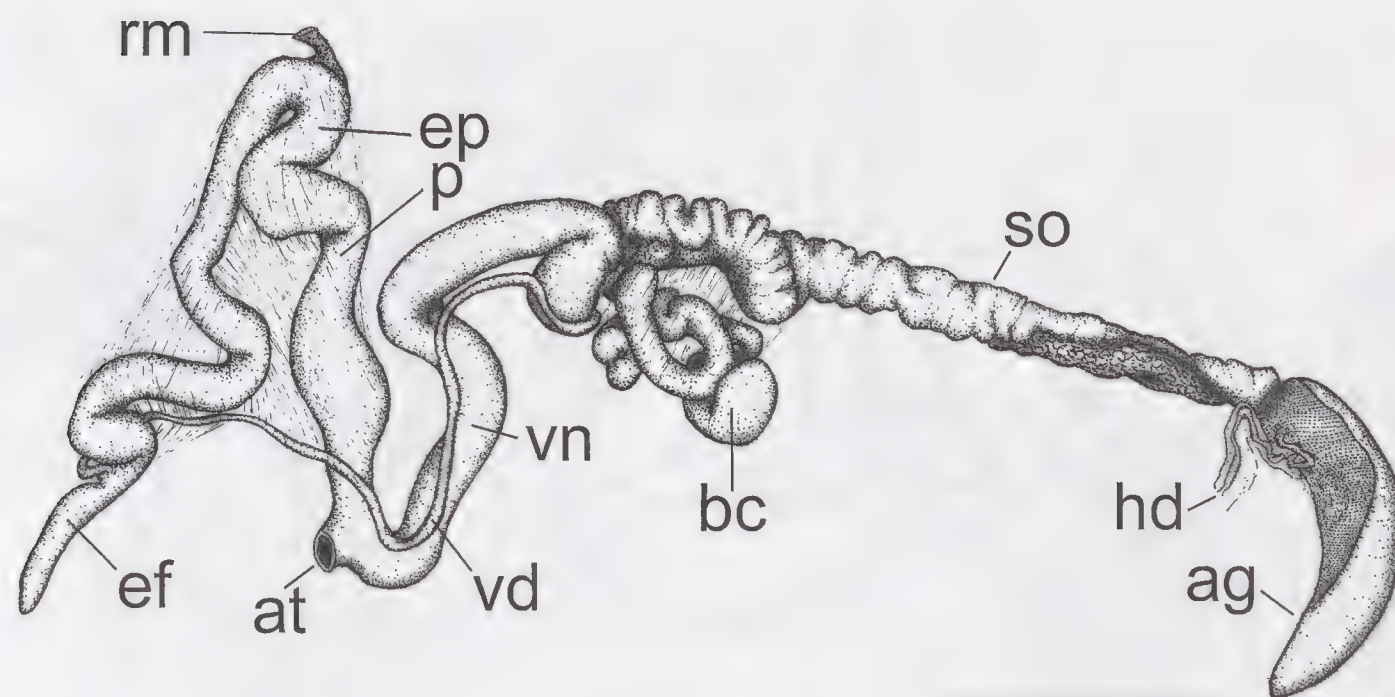


FIG. 98. Genital anatomy of *Retroterra discoidea* n. sp. paratype AM C471755 (Uwins Island, June). Scale bar = 5 mm.

***Retroterra discoidea* n. sp.**

Figs. 79K, 97C, D, 98, 99

Type Locality

Western Australia, central Kimberley coast, Bonaparte Archipelago, Hanover Bay, Uwins Island, 15°15'32"S, 124°48'08"E; coll. Vince Kessner, 9/06/2008, KIS 3–106 (vine thicket, large fig trees on upper slopes, piles of rocks, under large sandstone slabs).

Material Examined

Holotype WAM S58449 (preserved specimen; Fig. 79K, Table 6). Paratypes AM C471755 (10 preserved specimens), WAM S36999 (32 preserved specimens), WAM S37252 (10 shells) from type locality; WAM S37630 (4 preserved specimens), WAM S49036 (shell) from 15°15'32"S, 124°48'08"E.

Additional, non-type material. WAM S37248 (shell) from 15°15'52"S, 124°47'05"E; WAM S37249 (2 shells) from 15°16'02"S, 124°48'09"E; WAM S37250 (5 shells) from 15°15'26"S, 124°48'08"E; WAM S37251 (3 shells) from 15°15'45"S, 124°47'54"E; WAM S48037 (shell) from Myctyis Island, 15°13'12"S, 124°47'23"E.

Etymology

In reference to the discoidal shell; adjective of feminine gender.

Description

Shell (Figs. 79K, 97C, D): Medium sized (D = 17.5 mm on average; Table 6), perfectly

discoidal, with very low to slightly sunken spire. Umbilicus 4–6 mm wide. Protoconch with radially extended, well-developed pustulation, about one whorl (Fig. 97C). Teleoconch with strongly developed, regularly spaced axial ribs; ribs rounded in cross-section, running slightly sinuate across shell diameter, extending onto base of shell and into umbilicus (Fig. 97D). Apertural lip weakly to well produced, slightly reflected, parietal wall with well-developed callus, weakly descending, forming an angle of about 60°; nodes absent. Colour uniformly dark brown with only slightly lighter base.

Genital anatomy (Figs. 98–99): Penis moderately long; inner penial wall with complex, irregular pattern of oblique pilasters; their ends being interconnected through two lateral pilasters. Epiphallus very long, coiled; inner epiphallic wall with strongly developed longitudinal fold formed by two parallel running, adjacent longitudinal pilasters comprising entire length, plus more indistinct additional pilaster at anterior end; epiphallus opens to penial lumen through large, conical, pointed verge (Fig. 99A, B). Epiphallic flagellum comparatively long. Vagina tubular, long (much longer than free oviduct). Bursa copulatrix moderate in length, thin, coiled, extending base of spermoviduct, with kinked, slightly inflated head, entirely enclosed in tight connective tissue, connected to base of spermoviduct (Fig. 98).

Mitochondrial Differentiation

Interspecific genetic distances (1 sequence): 0.089 with respect to *R. acutocostata* (1 sequence), 0.105 to *R. aequabilis* (1 sequence), and 0.123 to *R. solituda* (2 sequences).

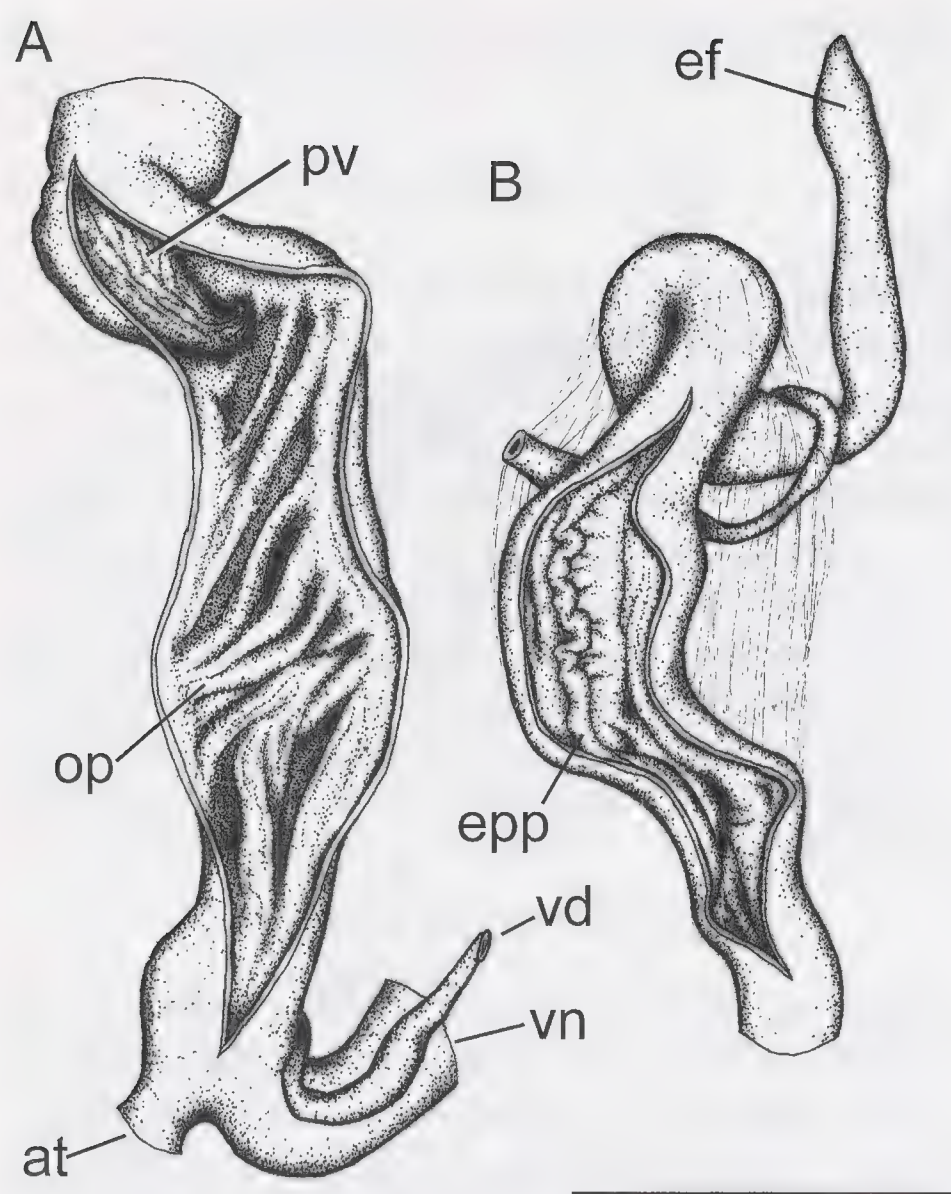


FIG. 99. Penial anatomy of *Retroterra discoidea* n. sp. paratype AM C471755 (Uwins Island, June). A: Section of the penial proper; B: Section of epiphallus. Scale bar = 3 mm.

Comparative Remarks

Most similar to *R. costa* in shell shape, size and sculpture (Table 6); the former being slightly smaller ($D = 13.4\text{--}19.4$ mm), with slightly more elevated spire, larger shell height (5.3–9.2 mm) and H/D ratio (0.43 on average). *Retroterra costa* differs by more regularly coiled bursa copulatrix, being kinked in *R. discoidea*. *Retroterra solitudo* has a larger shell with more elevated spire and differs most conspicuously in armature of inner penial and epiphallic walls.

Distribution (Fig. 96)

Uwins and Myctyis islands.

***Retroterra acutocostata* n. sp.**
Figs. 79L, 97E–F, 100, 101

Type Locality

Western Australia, central Kimberley coast, Hanover Bay, Munster Water, 1.3 km S of Halfway Bay, $15^{\circ}20'15''\text{S}$, $124^{\circ}49'23''\text{E}$; coll. Vince Kessner, 11/02/2009, KIS 3–133 (S-facing vine thicket at the base of sandstone cliffs; in leaf litter).

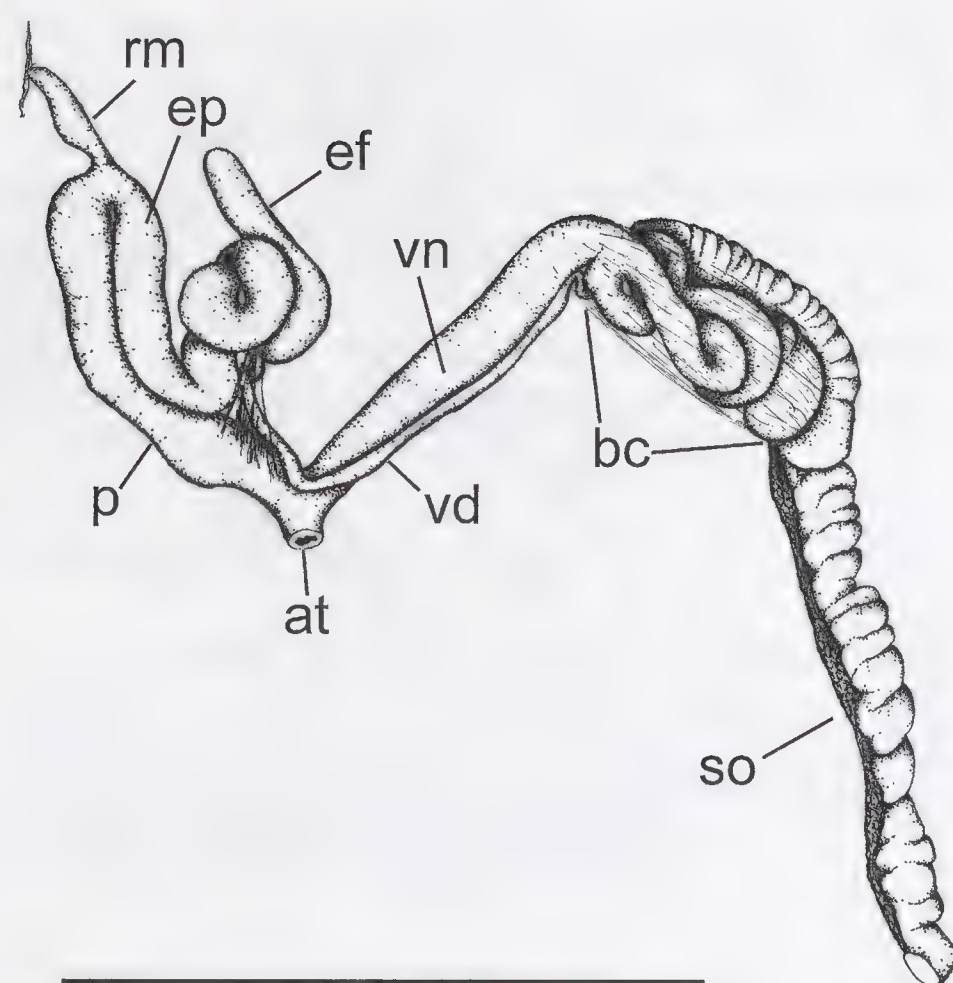


FIG. 100. Genital anatomy of *Retroterra acutocostata* n. sp. holotype WAM S58450 (albumen gland lacking). Scale bar = 10 mm.

Material Examined

Holotype WAM S58450 (preserved specimen; Table 6). Paratypes WAM S37644 (3 preserved specimens), WAM S49033 (3 shells), from type locality.

Etymology

In reference to the strong and acute ribs, derived from “*acutus*” (Latin = sharp) and “*costatus*” (Latin = ribbed); adjective of feminine gender.

Description

Shell (Figs. 79L, 97E, F): Medium sized ($D = 15.4$ on average; Table 6), nearly discoidal, with low spire. Umbilicus 4 mm wide. Protoconch with weak, radially extended pustulation, extending more than one whorl (Fig. 97E). Teleoconch with strongly developed, regularly spaced spiral ribs; ribs pointed in cross-section, running slightly sinuate across shell diameter, extending onto base of shell and into umbilicus (Fig. 97F). Apertural lip weakly produced, slightly reflected, parietal wall thinly callused; nodes absent. Colour uniformly dark brown including base of shell.

Genital anatomy (Figs. 100–101): Penis moderately long; inner penial wall with strong, corrugated longitudinal pilasters. Epiphallus very

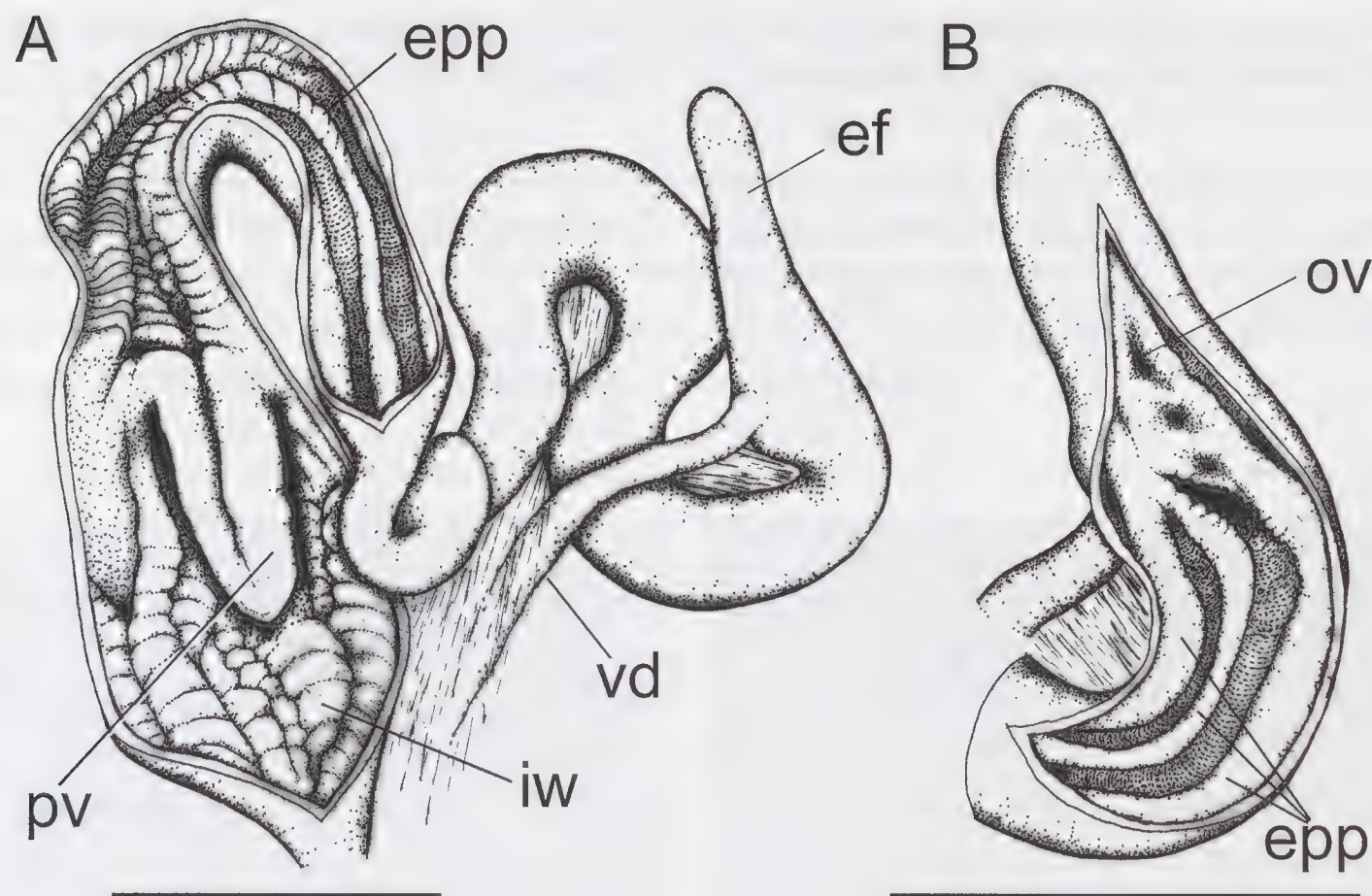


FIG. 101. Penial anatomy of *Retroterra acutocostata* n. sp. holotype WAM S58450. A: Section of penis; B: Section of epiphallus. Scale bars = 2 mm.

long, coiled; inner epiphallic wall supporting three longitudinal pilasters comprising entire length, pilasters smooth posteriorly, becoming corrugated anteriorly; epiphallus opens to penial lumen through very large, conical verge. Epiphallic flagellum well developed.

Mitochondrial Differentiation

Interspecific genetic distances (1 sequence): 0.089 with respect to *R. discoidea* (1 sequence), 0.113 to *R. aequabilis* (1 sequence), and 0.105 to *R. solitudo* (2 sequences).

Comparative Remarks

Shell smaller than in former two species (Table 6); also differing in stronger development of ribs being much weaker in *R. solitudo* and not as acute in *R. discoidea*. Diagnostic feature are conspicuously in thick, corrugated pilasters of inner penial wall.

Distribution (Fig. 96)

Mainland near Halfway Bay, Hanover Bay.

Molema n. gen.

Type Species

Molema stankowskii n. sp.

Etymology

Derived from the name of Molema Island, where the type species occurs; noun of feminine gender.

Description

Shell: Small ($D < 10$ mm; Table 7), discoidal with flat spire; widely open umbilicus; protoconch with radially arranged, crowded pustules; teleococonch with strong radial ribs, most prominent on last whorl; no well-developed microsculpture; whorls moderately increasing, deep suture; well-rounded periphery.

Genital anatomy: Penis without penial sheath and well-developed epiphallus with short flagellum. Penial retractor muscle attached at distal end of epiphallus. Epiphallus opens to penial lumen through complexly folded vergic ring. Vas deferens entering epiphallus terminally. Bursa copulatrix elongated, kinked, extending anterior end of spermoviduct.

Aestivation Strategy

Free sealer.

Comparative Remarks

Shell similar to *Baudinella* and *Setobaudinia* in overall shape and size, differing by larger

TABLE 7. Shell parameters of *Molema* (in mm), given are maximum – minimum (mean ± standard deviation) for N measured specimens. Abbreviations used: HT = holotype.

Species	N	Height (H)	Diameter (D)	Whorls	H/D Ratio
<i>M. stankowskii</i> n. sp.	HT	3.2	8.9	3.2	0.36
	5	2.8–3.4 (3.2 ± 0.2)	7.8–8.9 (8.4 ± 0.4)	3.0–3.5 (3.2 ± 0.2)	0.36–0.40 (0.38 ± 0.02)

diameter, perfectly dicoidal shape and flat spire, absence of microsculpture or setae, presence of strong, noduled ribs, and absence of apertural nodes. Genitalia similar to *Baudinella* and *Retroterra*, differing most conspicuously by very complex vergic ring that separates lumen of epiphallus and penis as well as by large stimulatory pilaster at posterior end of inner penial wall. In addition, differing from *Retroterra* by shorter and simpler bursa copulatrix and simpler armature of inner penial wall.

Diversity and Distribution (Fig. 102)

One species on Molema Island, Talbot Bay.

Molema stankowskii n. sp.
Figs. 79M, 103–105

Type Locality

Western Australia, southwestern Kimberley, Buccaneer Archipelago, Talbot Bay, N section of

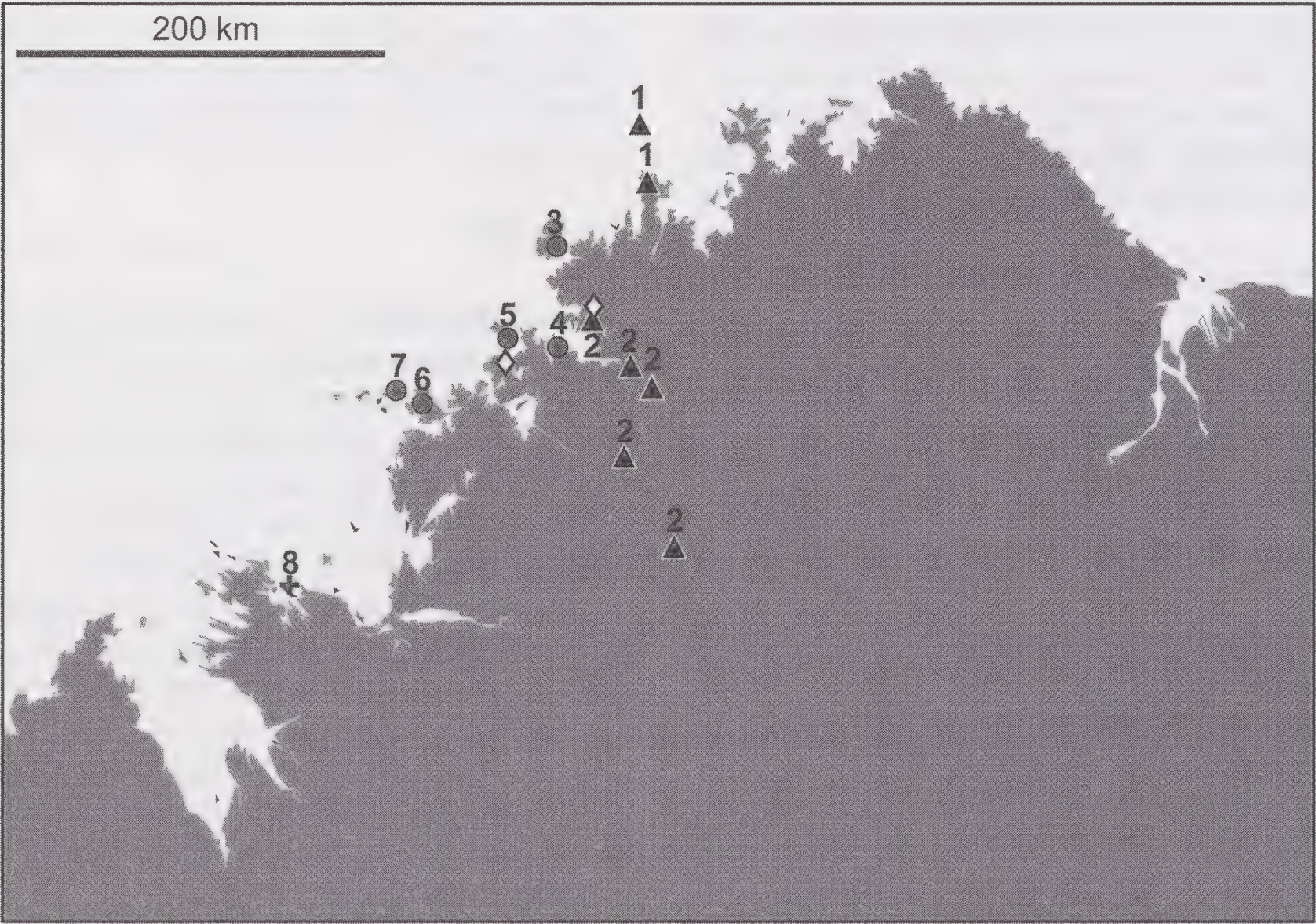


FIG. 102. Distribution map of *Molema* n. gen. and *Baudinella*. Triangles = records of Solem (1985, 1991): 1: *Baudinella baudinensis* (Baudin Island, Bougainville Peninsula), 2: *B. regia* (mainland); circles = new records: 3: *B. thielei* n. sp. (Bigge Island), 4: *B. boongareensis* n. sp. (Boongaree Island), 5: *B. tuberculata* n. sp. (Coronation Island), 6: *B. setobaudinioides* n. sp. (Augustus Island), 7: *B. occidentalis* n. sp. (D'Arcy Island), 8: *Molema stankowskii* n. sp. (Molema Island); diamonds = records of undescribed taxa listed by Solem (1991).

Molema Island, 16°15'02.4"S, 123°49'23.5"E; coll. Sean Stankowski, 30/05/2009, KIS 2-81 (between rocks in soil and litter at base of eucalypts).

Material Examined

Holotype WAM S58447 (preserved specimen; Fig. 79M). Paratypes WAM S37775 (3 preserved

specimens), from type locality; WAM S37774 (preserved specimen), from 16°15'09.7"S, 123°49'11.7"E; AM C471753 (preserved specimen), WAM S37773 (3 preserved specimens), AM C471754 (shell), WAM S37899 (2 shells), from 16°15'14"S, 123°29'28"E; WAM S37900 (shell), WAM S37901 (shell), from 16°15'00"S, 123°49'29"E.



FIG. 103. SEM micrographs of the shell of *Molema stankowskii* n. sp. (Molema Island). A–B, D, E: Paratype AM C471754. C, F: Paratype AM C471753. A: Apical view showing protoconch and first whorl; B: Close-up of sculpture across entire shell, viewed from above; C: Close-up of sculpture on last whorl, viewed obliquely from above; D: Entire shell viewed from above; E: Umbilicus viewed from below; F: Sculpture at base of shell and basal lip, viewed from below. Scale bars = 1 mm.

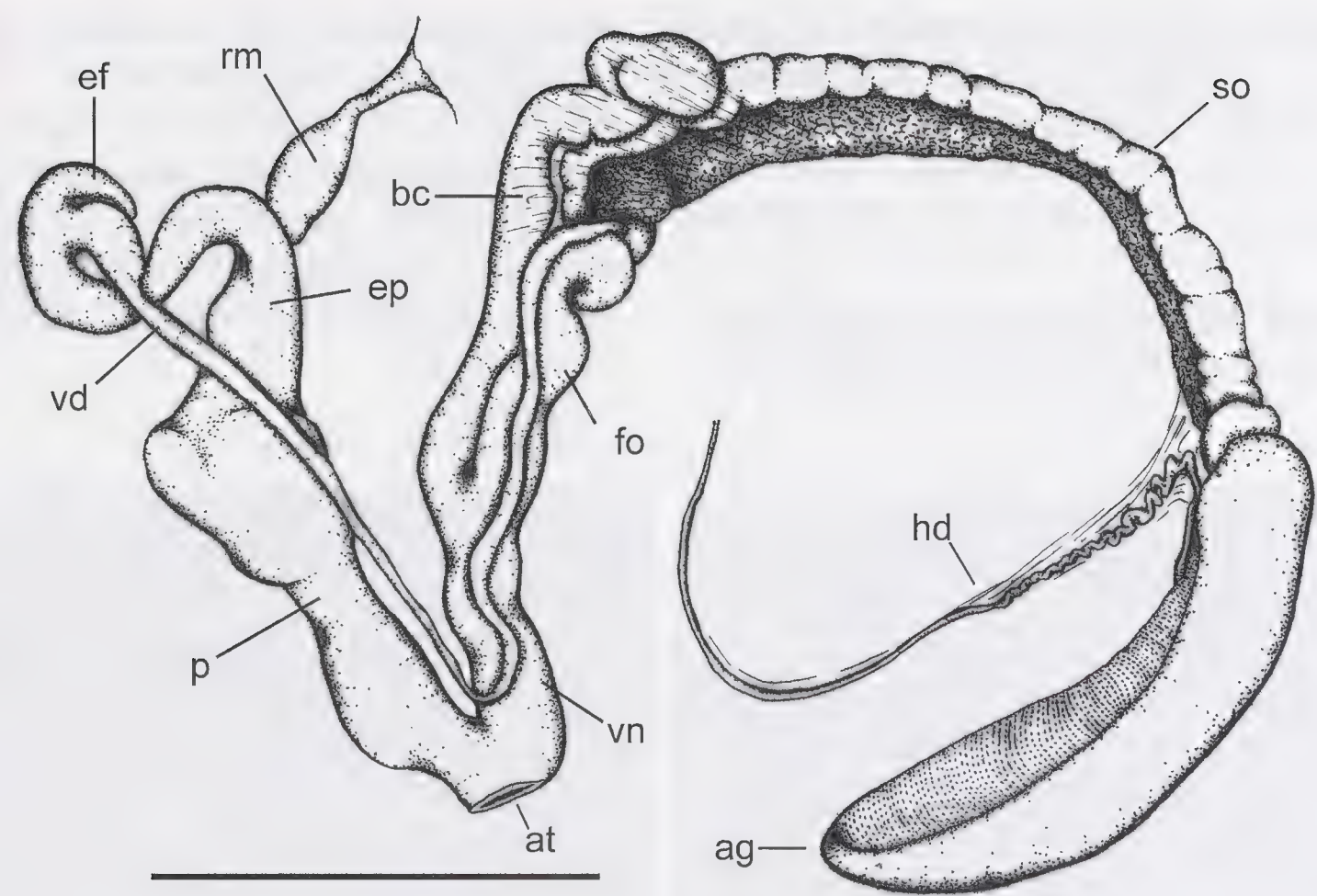


FIG. 104. Genital anatomy of *Molema stankowskii* n. sp. paratype WAM S37775 (Molema Island). Scale bar = 3 mm.

Etymology

Named in honour of Sean Stankowski (Perth), who collected the type material, noun in genitive case.

Description

Shell (Figs. 79M, 103): Small (D= 8.4 mm on average, Table 7), perfectly discoidal; body whorl almost not descending. Umbilicus 2.5–3.2 mm wide. Protoconch extending one whorl. Teleconch with strongly developed, widely spaced radial ribs, most prominent on last whorl; ribs support spiral rows of rounded nodules; which diffuse into radial rows of nodules on base of shell and inner umbilical whorls. Periphery of last whorl well rounded, deeply incised suture. Shell colour uniformly brown. Lip of aperture relatively thin, moderately expanded, weakly reflected, basal edge slightly curved; no prominent palatal or basal nodes; parietal wall very thin.

Genital anatomy (Figs. 104–105): Penis about as long as anterior part of oviduct, with inflated proper; epiphallus about same length as penis, with short epiphallic flagellum near posterior end. Vergic papilla covered by large stimulatory pilaster at proximal end of inner penial wall, which supports fine, dense pustulation on exterior and more strongly developed pustulation on interior surface. Penial wall extremely delicate posteriorly; interiorly supporting several (about six to seven) well developed longitudinal pilasters. Bursa copulatrix

elongate, extending anterior end of spermoviduct, head slightly inflated, S-folded, connected to base of spermoviduct by connective tissue.

Distribution

Molema Island, Talbot Bay.

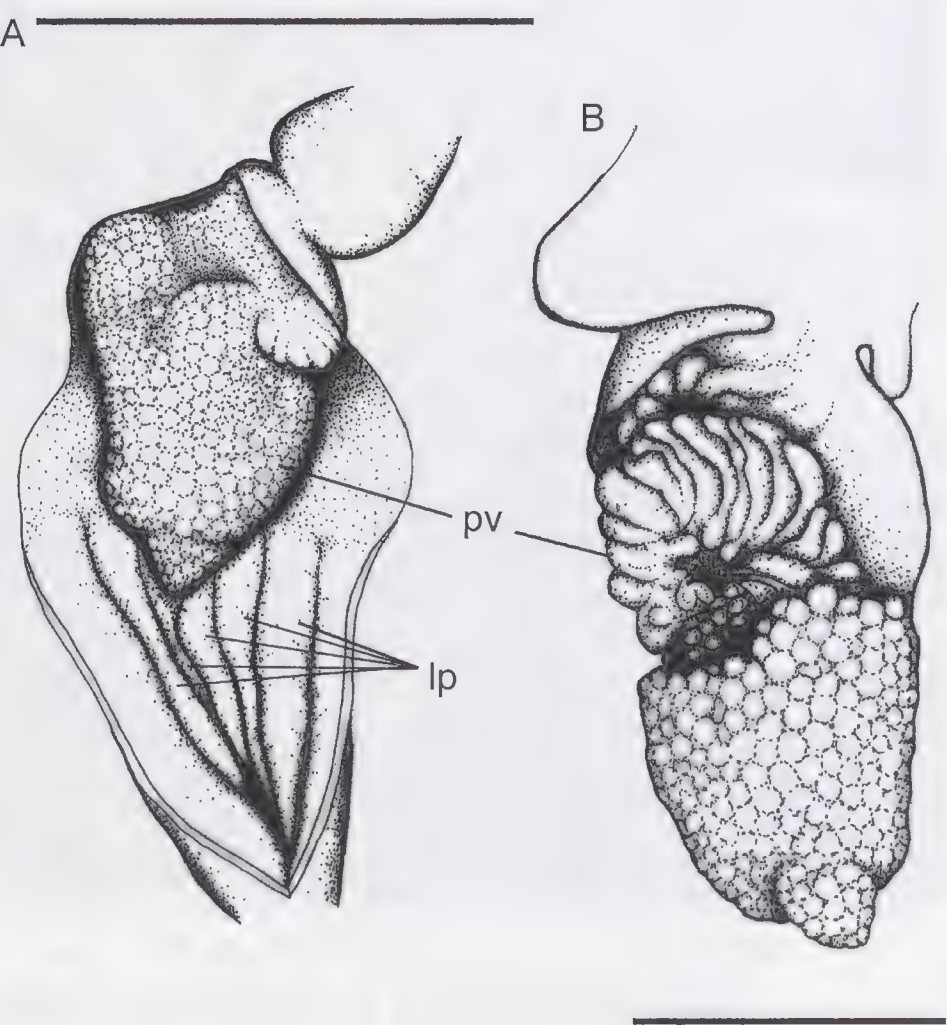


FIG. 105. Penial anatomy of *Molema stankowskii* n. sp. paratype WAM S37775 (Molema Island). A: Penial anatomy. Scale bar = 2 mm; B: Backside of penial verge in detail. Scale bar = 1 mm.

Baudinella Thiele, 1931

Baudinella Thiele, 1931: 685. Iredale, 1938: 109; 1939: 49; Solem, 1985a: 775–787; 1991: 207–209; Solem & McKenzie, 1991: 247–263. Type species: *Helix* (*Gonostoma*) *baudinensis* E. A. Smith, 1893, by original designation.
Gonobaudinia Iredale, 1933: 55. Type species: *Helix* (*Gonostoma*) *baudinensis* E. A. Smith, 1893, by original designation.

Taxonomic Remarks

The two generic names *Baudinella* Thiele, 1931, and *Gonobaudinia* Iredale, 1933, were introduced for the same type species, *Helix* (*Gonostoma*) *baudinensis* E. A. Smith, 1893, and are therefore objective synonyms; the older name *Baudinella* having priority. Solem (1985a) described the anatomy and provided a comprehensive overview of its taxonomic history. He also described a second species, *Baudinella regia* Solem, 1985, from Prince Regent Reserve.

Diagnosis

Shell: Small (D = 6.5–7.5 mm; Table 8), discoidal with flat to moderately elevated spire; umbilicus moderately to widely open, not concealed; protoconch with more or less developed irregularly to densely spaced tubercles; teleococonch without or with closely to moderately spaced, weakly to well-developed radial ribs that are more prominent on last whorl, microsculpture of tiny projections or anas-

tomosing ridglets plus widely spaced, short periostracal setae, often lost in adults; whorls narrowly winding, separated by deep suture; body whorl slightly to moderately descending, periphery well rounded. Shell colour uniform, yellowish brown to brown. Lip of aperture strongly expanded, basal and palatal edges curved; outer palatal node weak to conspicuously thickened internally, basal node absent to prominent, parietal wall inconspicuous or with thin callus.

Radula: 1–2 mm long; C + 6–8 + 2–3 + 10–14.

Genital anatomy: Penis without penial sheath, with well-developed, reflected or winding epiphallus with minute to short flagellum. Inner penial wall supporting two to four, more or less developed longitudinal pilasters. Penial retractor muscle attached at epiphallus near connection with penial complex. Epiphallus opens to penial lumen through simple, wide vergic ring. Vas deferens entering epiphallus terminally. Bursa copulatrix extending anterior end of spermoviduct, mostly S-folded.

Aestivation Strategy

Free sealer (modified after Solem, 1985a).

Comparative Remarks

Species of *Baudinella* are readily distinguished from all other Kimberley camaenids except *Setobaudinia* and ***Molema*** (see above for comparison with ***Molema***) by their small size, discoid shell, wide umbilicus, occasional presence of periostracal setae (at least in juve-

TABLE 8. Shell parameters of *Baudinella* (in mm), given are maximum – minimum (mean ± standard deviation) for N measured specimens.

Species	N	Height (H)	Diameter (D)	Whorls	H/D Ratio
<i>B. thielei</i> n. sp.	13	2.8–3.3 (3.1 ± 0.2)	6.8–7.3 (7.1 ± 0.1)	3.1–3.3 (3.2 ± 0.1)	0.39–0.47 (0.43 ± 0.02)
<i>B. boongareensis</i> n. sp.	11	2.8–3.5 (3.0 ± 0.2)	6.6–7.5 (7.0 ± 0.3)	3.0–3.5 (3.2 ± 0.1)	0.38–0.47 (0.43 ± 0.03)
<i>B. tuberculata</i> n. sp.	15	3.1–3.8 (3.5 ± 0.2)	6.5–7.3 (6.8 ± 0.2)	3.1–3.5 (3.8 ± 0.1)	0.48–0.55 (0.51 ± 0.02)
<i>B. setobaudinioides</i> n. sp.	11	2.8–3.6 (3.1 ± 0.3)	6.7–7.6 (7.0 ± 0.3)	2.9–3.6 (3.2 ± 0.2)	0.41–0.51 (0.44 ± 0.03)
<i>B. occidentalis</i> n. sp.	16	2.5–3.2 (2.9 ± 0.2)	6.1–7.0 (6.6 ± 0.3)	3.0–3.4 (3.2 ± 0.1)	0.40–0.46 (0.43 ± 0.02)

niles), and strongly reflected, thick apertural lip with curved edges. *Setobaudinia* species are very similar in shell shape and size and cannot be readily distinguished from *Baudinella* by means of their shell. Solem (1985a), who knew only two *Baudinella* species, stated that shells essentially differ from *Setobaudinia* by presence of radial ribs and by prominence of nodes of apertural lip. However, some *Baudinella* species have very weak or no axial ribs and several have only weakly developed nodes, which do not differ from those found in *Setobaudinia*. Rather, shells differ microscopically in that radial growth lines or even ribs are

present in *Baudinella* but much weaker or absent in *Setobaudinia*. Usually, *Setobaudinia* exhibits a regular pattern of radially arranged periostracal projections not found in *Baudinella*. Many *Baudinella* species have a more strongly reflected apertural lip, but this feature is not diagnostic for all species. Most reliably, the genera can be differentiated by their genital anatomy. Important key features are shorter bursa copulatrix extending anterior end of spermoviduct (reaching anterior end of albumen gland in *Setobaudinia*), absence of penial verge and lateral lamellae of interior penial wall (present in *Setobaudinia*).

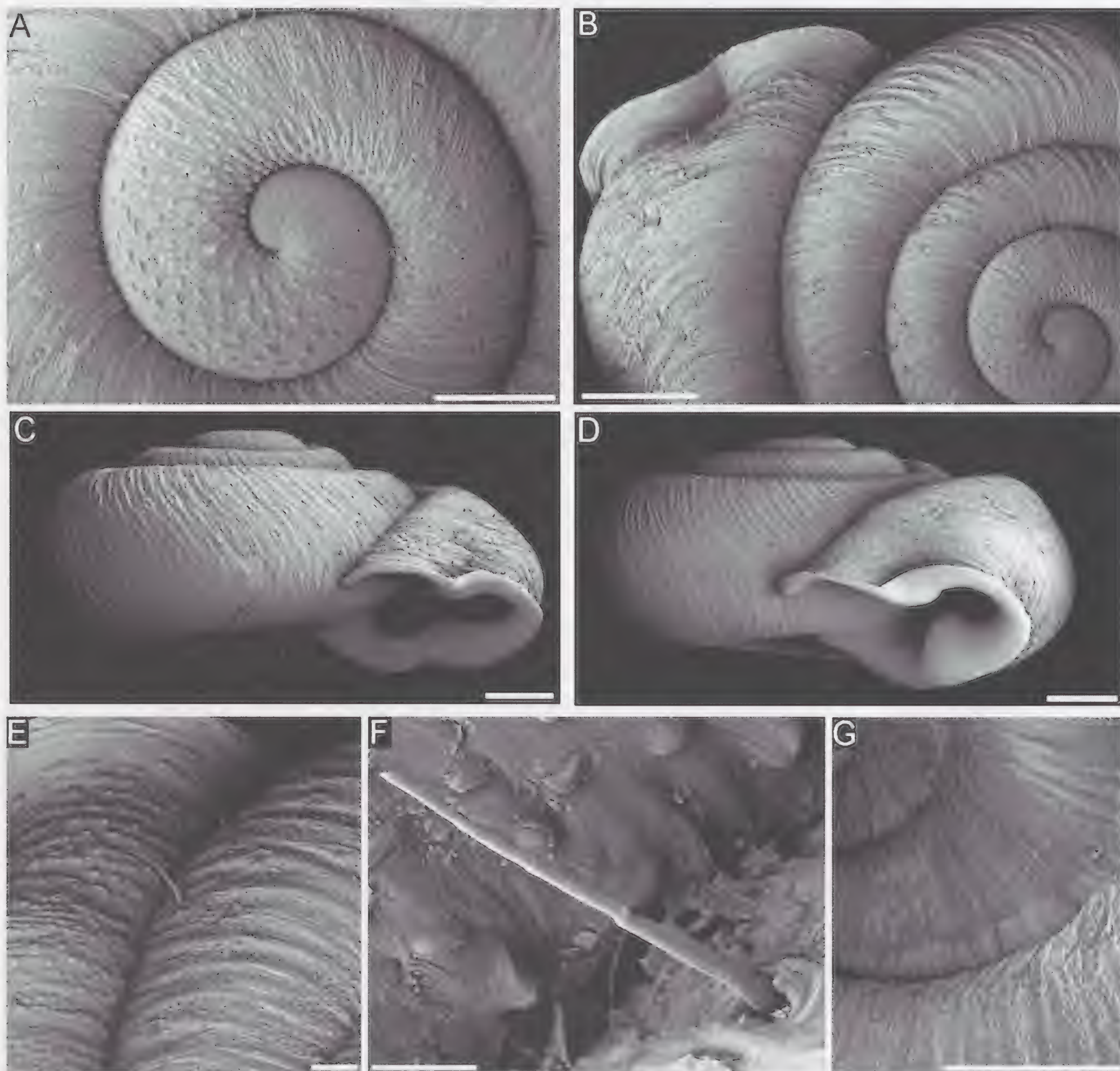


FIG. 106. SEM micrographs of shells of *Baudinella thielei* n. sp. paratype AM C471738 (Bigge Island). A: Apical view showing protoconch. Scale bar = 500 μ m; B: Sculpture across entire shell viewed from above; C: Lateral view of last whorl; D: Lateral view on aperture showing dentition. Scale bars B–D = 1 mm; E: Detail of sculpture on last whorl behind aperture, viewed from above. Scale bar = 200 μ m; F: Close-up of periostracal hair. Scale bar = 50 μ m; G: Inner umbilical whorls. Scale bar = 500 μ m.

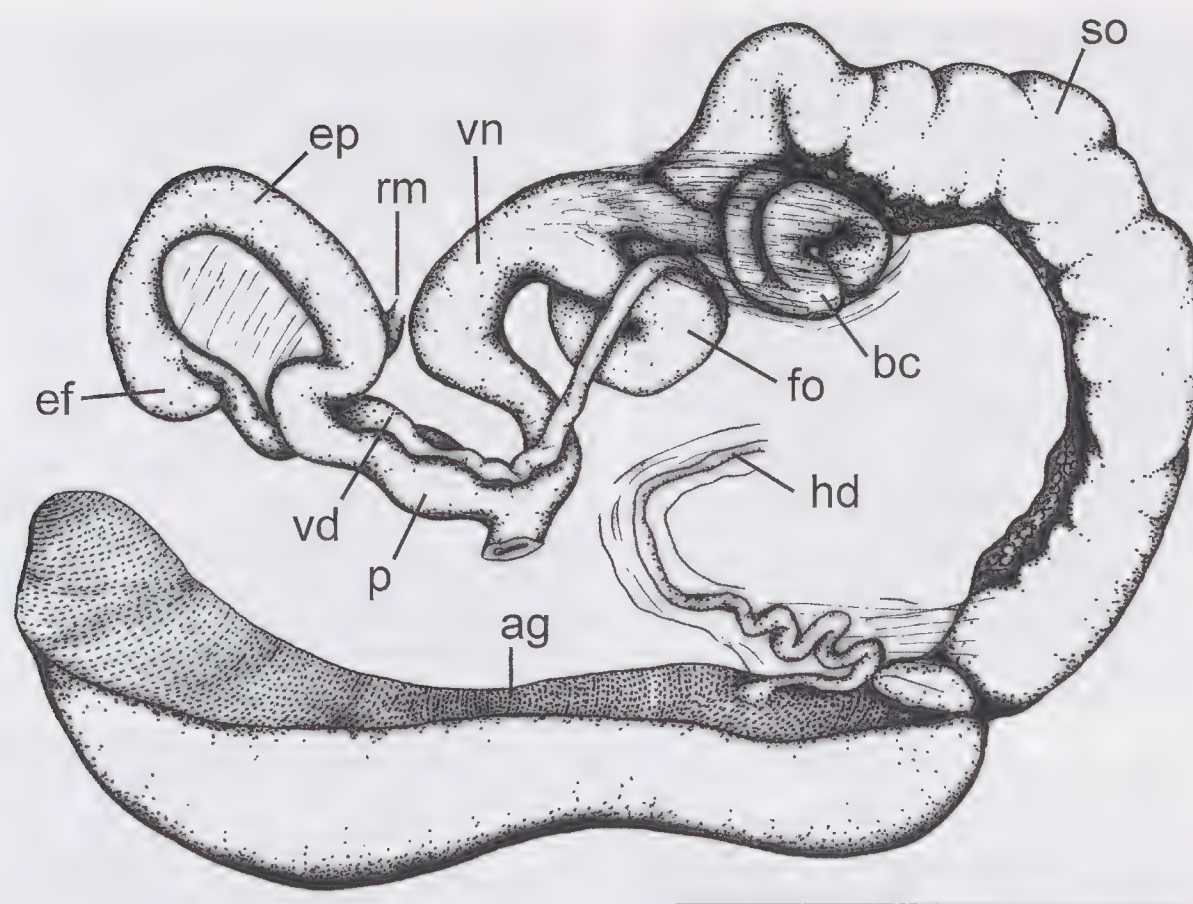


FIG. 107. Genital anatomy of *Baudinella thielei* n. sp. holotype WAM S58442 (Bigge Island, July). Scale bar = 2 mm.

Diversity and Distribution (Fig. 102)

Next to the type species, *B. baudinensis* from Baudin Island, Admiralty Gulf, Solem (1985a) described a second species from the Prince Regent Reserve. Solem (1991) listed two undescribed taxa from coastal localities in the York Sound, Prince Frederick Harbour and Bigge Island. Here five new species are being described from Bigge (previously listed as undescribed), Boongaree, Augustus, Coronation and D'Arcy islands, respectively.

Baudinella thielei n. sp.
Figs. 79N, 106–108

Type Locality

Western Australia, northwestern Kimberley, Bonaparte Archipelago, Bigge Island, 14°35'33"S, 125°11'19"E; coll. Michael Shea, 27/07/2007, KIS 1–5 (S-facing slopes, mixed eucalyptus and dry vine thicket on sandstone scree, northern side of a creek valley; aestivating in soil under litter).

Material Examined

Holotype WAM S58442 (preserved specimen, dissected). Paratypes WAM S36756 (4 preserved specimens), WAM S36397 (15 shells); WAM S36394 (8 shells) from 14°35'20"S, 125°11'07"E; WAM S36395 (shell) from 14°35'27"S, 125°11'03"E; WAM

S36396 (20 shells), AM C471737 (14 shells) from 14°35'16"S, 125°11'06"E; WAM S36398 (15 shells, 5 preserved specimens) from 14°35'16"S, 125°11'02"E; WAM S36975 (50 shells), AM C471738 (28 shells) from 14°35'16"S, 125°11'02"E; WAM S36399 (shell)

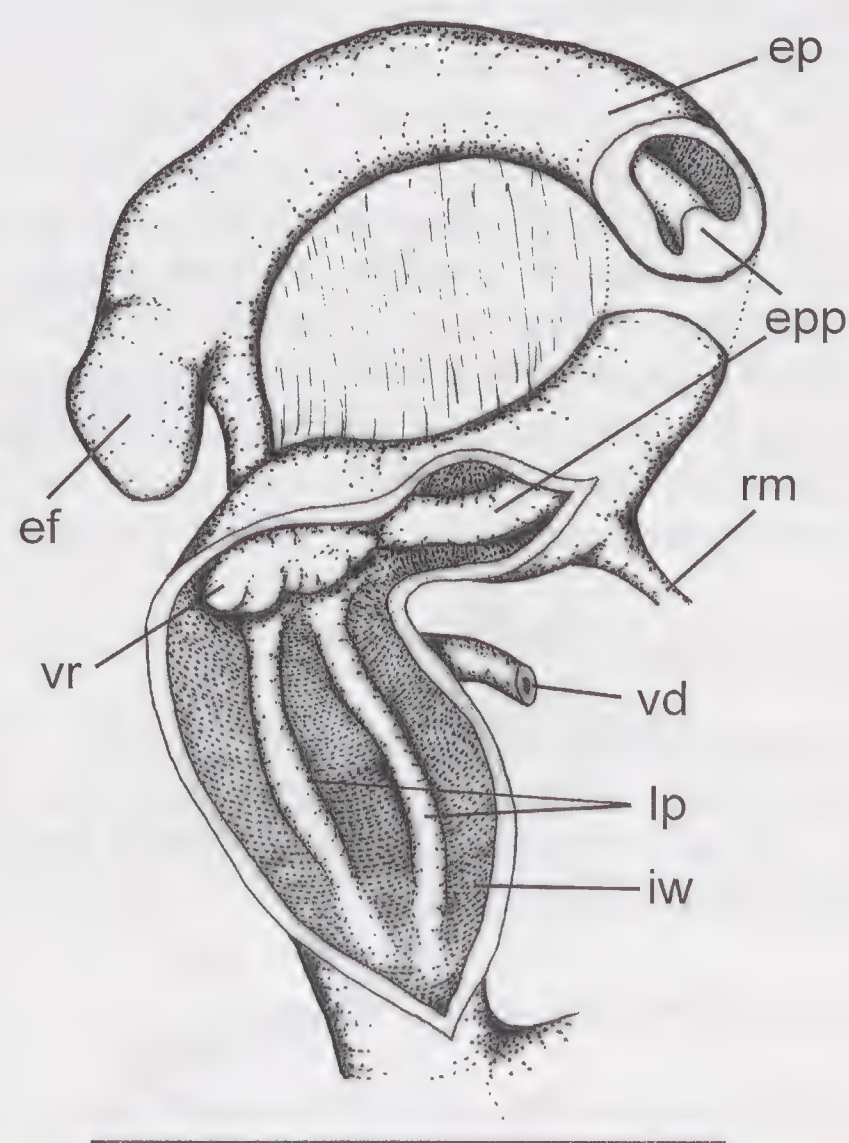


FIG. 108. Penial anatomy of *Baudinella thielei* n. sp. holotype WAM S58442 (Bigge Island, July). Scale bar = 1 mm.

from 14°35'19"S, 125°11'08"E; WAM S36400 (7 shells) from 14°35'10"S, 125°11'06"E; WAM S36900 (preserved specimen) from 14°35'15"S, 125°11'05"E.

Etymology

Named in honour of Johannes Thiele, former curator of Mollusca at the Museum of Natural History, Berlin, who named this genus; noun in genitive case.

Description

Shell (Figs. 79N, 106): Small ($D = 7.1$ mm on average, Table 8), with low spire. Protoconch with well developed, radially arranged, densely spaced, comparatively large tubercles; extending < 1 whorl. Teleoconch with narrowly spaced, indistinct to fine radial ribs (most prominent on first whorl and base of shell), and microsculpture of tiny projections, irregularly spaced, thin and short periostracal hairs may be present, but mostly worn in adults. Lip of aperture strongly expanded and reflected, thickened; outer palatal node conspicuously thickened, basal node well developed, parietal wall with thin callus.

Genital anatomy (Figs. 107–108): Penis comparatively short (clearly shorter than vagina). Epiphallus comparatively long (much longer than penis), reflected, supporting a short but comparatively wide epiphallic flagellum at distal end of epiphallus; inner epiphallic wall supporting one well-developed longitudinal pilaster. Inner penial wall supporting two rather weak longitudinal pilasters, most prominent at posterior part of inner wall, tapering anteriorly. Vagina elongate, winding. Bursa copulatrix extending anterior end of spermoviduct, head heavily coiled, attached to base of spermoviduct by connective tissue.

Mitochondrial Differentiation

Intraspecific genetic divergence: 0.007 (2 sequences); interspecific distances with respect to all other congeners: 0.133–0.160 (8 sequences, 3 species).

Comparative Remarks

Identical with "*Baudinella* NSP8" listed by Solem (1991) from Bigge Island and adjacent mainland. Most similar to *Baudinella baudinensis* and *B. regia* in having radial ribs and well-developed nodes at apertural lips but

differs by more indistinct, closely spaced axial ribs. Typical for the present species is presence of two longitudinal penial pilasters. In addition, genitalia differ most conspicuously by presence of only one epiphallic pilaster and by heavily coiled head of bursa copulatrix.

Distribution (Fig. 102)

Bigge Island, in vine thickets; occurrence on adjacent mainland as mentioned by Solem (1991) awaits confirmation by comparative study of suitable material.

Baudinella boongareensis n. sp.

Figs. 79O, 109–111

Type Locality

Western Australia, northwestern Kimberley, Bonaparte Archipelago, central section of Boongaree Island, 15°04'00"S, 125°11'11"E; coll. Michael Shea, 10/08/2007, KIS 1–34 (patches of vine thicket on W-facing dolerite slopes, talus; in soil under rocks and litter).

Material Examined

Holotype WAM S58443 (preserved specimen, dissected). Paratypes WAM S36747 (6 preserved specimens), AM C471739 (3 preserved specimens), WAM S36390 (5 shells), WAM S36391 (29 shells) from type locality; AM C471741 (3 preserved specimens), WAM S36743 (8 preserved specimens), AM C471740 (17 shells), WAM S36387 (40 shells), WAM S36388 (88 shells) from 15°04'31"S, 125°11'07"E; WAM S36386 (3 shells) from 15°04'21"S, 125°11'06"E; AM C471742 (15 preserved specimens), WAM S36744 (24 preserved specimens) from 15°04'36"S, 125°11'12"E; WAM S36745 (7 preserved specimens) from 15°04'15"S, 125°11'14"E; WAM S36746 (10 preserved specimens), WAM S36389 (21 shells) from 15°04'08"S, 125°11'05"E; WAM S36392 (9 shells) from 15°04'36"S, 125°11'18"E; WAM S36393 (9 shells) from 15°04'33"S, 125°10'58"E; WAM S37686 (6 preserved specimens) from 15°04'30"S, 125°11'21"E; WAM S37687 (5 preserved specimens), WAM S49054 (2 shells) from 15°04'19"S, 125°11'18"E.

Etymology

In reference to the type locality, Boongaree Island; adjective of feminine gender.

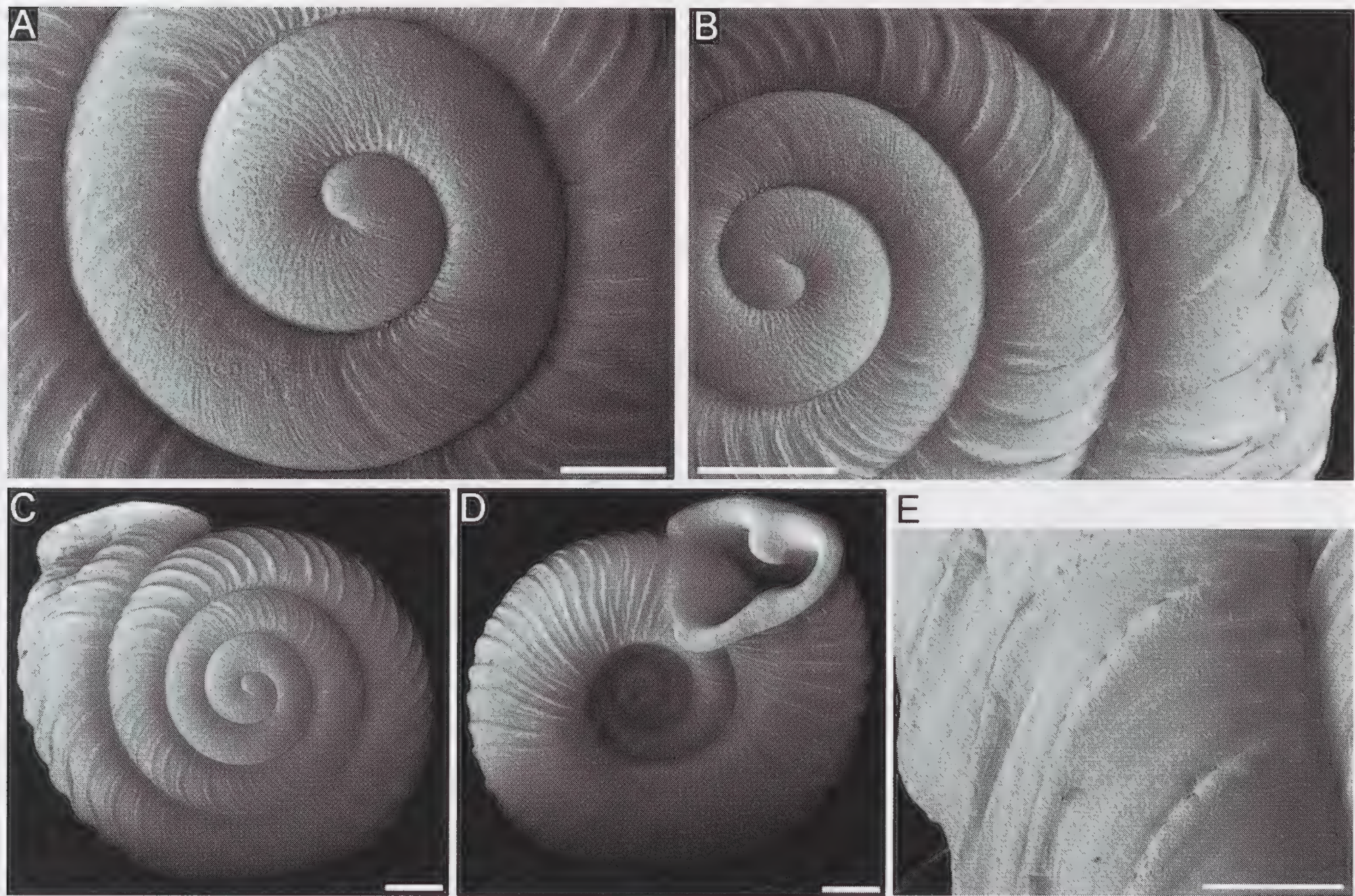


FIG. 109. SEM micrographs of shells of *Baudinella boongareensis* n. sp. paratype AM C471740 (Boongaree Island). A: Apical view showing protoconch and first whorl. Scale bar = 500 μ m; B: Sculpture across entire shell viewed from above; C: Entire shell viewed from above; D: Entire shell viewed from below showing umbilicus and aperture with dentition. Scale bars B–D = 1 mm; E: Detail of sculpture on last whorl behind aperture, viewed from above. Scale bar = 500 μ m.

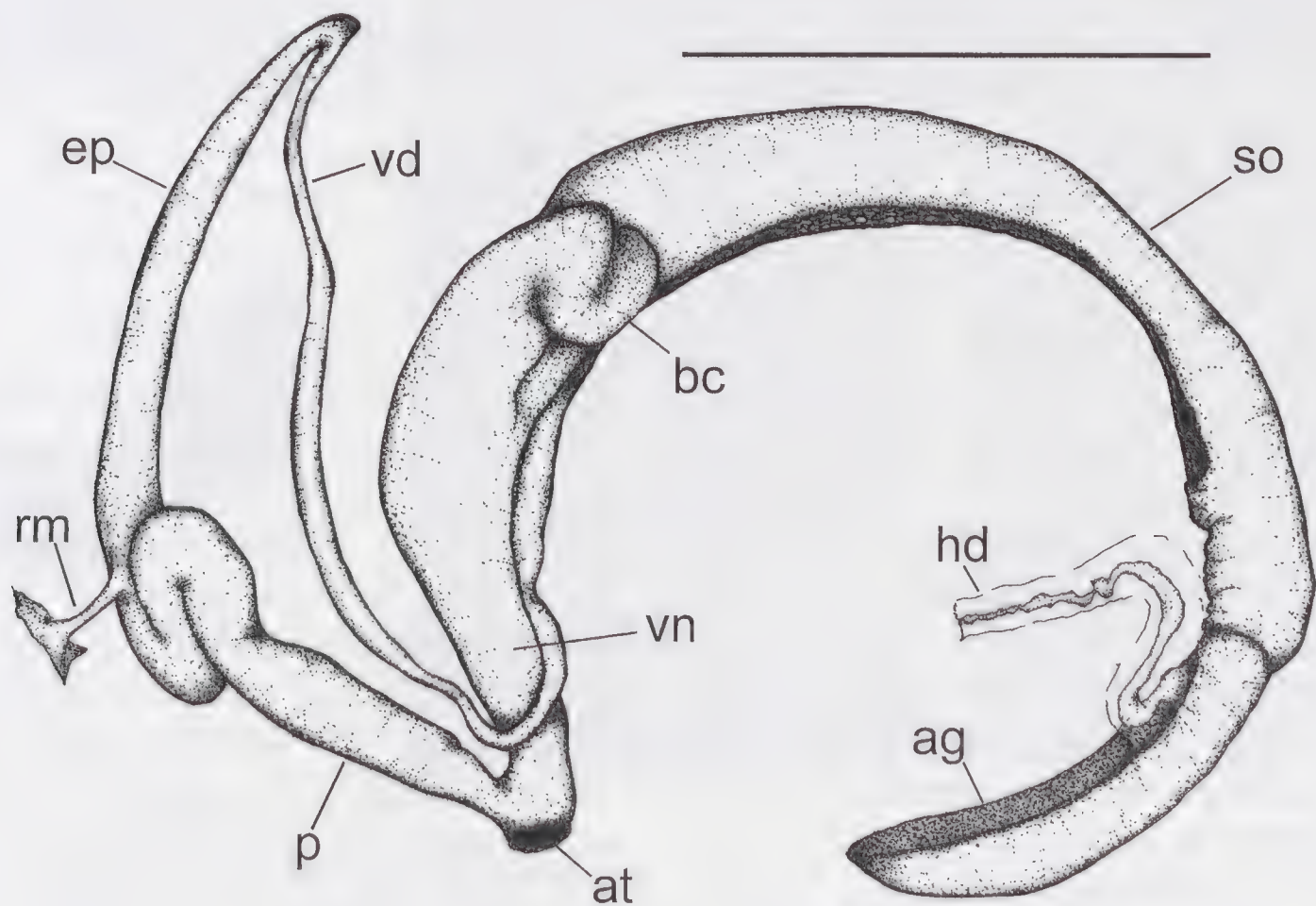


FIG. 110. Genital anatomy of *Baudinella boongareensis* n. sp. holotype WAM SS58443 (Boongaree Island, August). Scale bar = 3 mm.

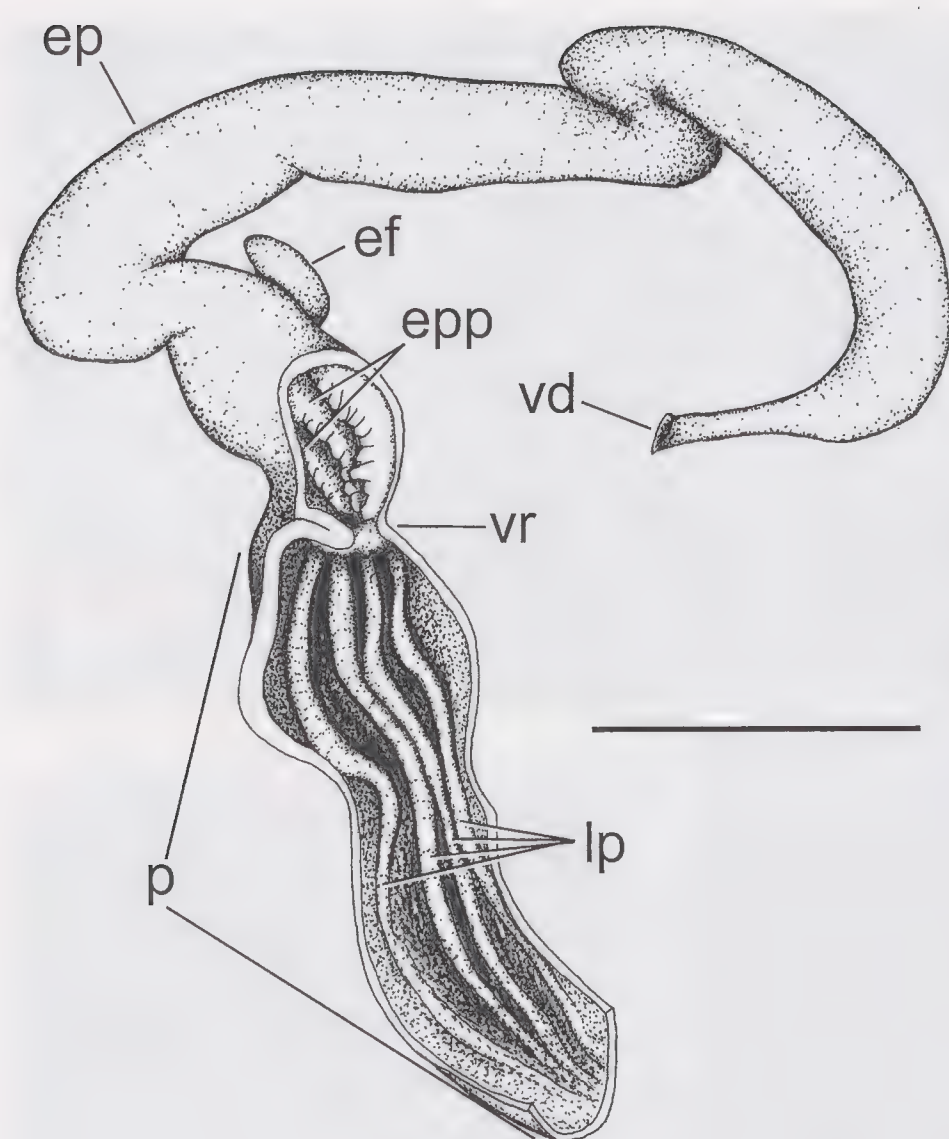


FIG. 111. Penial anatomy of *Baudinella boongareensis* n. sp. holotype WAM SS58443 (Boongaree Island, August). Scale bar = 1 mm.

Description

Shell (Figs. 79O, 109): Small ($D = 7.0$ mm on average, Table 8), with low spire. Protoconch with well developed, radially arranged, densely spaced tubercles; extending about one whorl. Teleoconch with widely spaced, very strong radial ribs (most prominent on first whorl and base of shell), very sparse and indistinct microsculpture of tiny projections, periostracal setae absent. Lip of aperture strongly expanded and reflected, thickened; outer palatal and basal nodes strongly developed, parietal wall callused.

Genital anatomy (Figs. 110–111): Penis elongate, straight. Epiphallus longer than penis, reflected, supporting a very short epiphallic flagellum near distal end; inner epiphallic wall supporting two longitudinal pilasters. Inner penial wall supporting four well-developed longitudinal pilasters along entire surface that taper anteriorly. Vagina about as long as penis. Bursa copulatrix extending anterior end of spermoviduct, head S-folded, attached to base of spermoviduct by connective tissue.

Comparative Remarks

Most similar to *B. baudinensis* in having strongly developed, widely spaced, radial ribs

and very prominent nodes of apertural lip; differing essentially by development of penial wall pilasters. Shell differs from other congeners by strong, widely spaced radial ribs.

Distribution (Fig. 102)

Boongaree Island, in vine thickets.

***Baudinella tuberculata* n. sp.**
Figs. 79P, 112–115

Type Locality

Western Australia, northwestern Kimberley, Bonaparte Archipelago, southern section of Coronation Island, $15^{\circ}01'45''S$, $124^{\circ}56'49''E$; coll. Vince Kessner, 1/06/2008, KIS 3–90 (vine thicket on lower and middle slopes, cliffs, scree; abundant under rocks in loose soil).

Material Examined

Holotype WAM S58444 (preserved specimen, dissected). Paratypes AM C471743 (43 preserved specimens), WAM S37062 (103 preserved specimens), AM C471744 (30 shells), WAM S37259 (68 shells) from type locality; AM C471745 (50 preserved specimens), WAM S37056 (100 preserved specimens), AM C471746 (49 shells), WAM S37253 (80 shells) from $15^{\circ}01'47''S$, $124^{\circ}57'15''E$.

Additional non-type material WAM S37256 (8 shells) from $15^{\circ}01'42''S$, $124^{\circ}57'08''E$; WAM S37057 (56 preserved specimens), WAM S37254 (62 shells) from $15^{\circ}01'49''S$, $124^{\circ}57'17''E$; WAM S37058 (27 preserved specimens), WAM S37255 (22 shells) from $15^{\circ}01'52''S$, $124^{\circ}56'56''E$; WAM S37059 (24 preserved specimens), WAM S37257 (12 shells) from $15^{\circ}01'55''S$, $124^{\circ}56'59''E$; WAM S37061 (48 preserved specimens), WAM S37258 (34 shells) from $15^{\circ}01'27''S$, $124^{\circ}56'28''E$; WAM S37063 (55 preserved specimens), WAM S37260 (8 shells) from $15^{\circ}01'58''S$, $124^{\circ}57'21''E$; WAM S37261 (14 shells) from $15^{\circ}01'59''S$, $124^{\circ}57'15''E$; WAM S37060 (6 preserved specimens) from $15^{\circ}01'59''S$, $124^{\circ}56'53''E$; AM C471747 (shell), WAM S49047 (2 shells) from Malby Island, northwest of Coronation Island, $14^{\circ}57'00''S$, $124^{\circ}53'27''E$.

Etymology

From “*tuberculum*” (Latin = small swelling); in reference to conspicuously fine tuberculation of

the shell being typical for this species; adjective of feminine gender.

Description

Shell (Figs. 79P, 112A–E, 113): Small ($D = 6.8$ mm on average, Table 8), with moderately

elevated spire. Protoconch with strongly developed, radially arranged tubercles; extending about one whorl. Teleoconch entirely covered with strongly developed, radially arranged tubercles, radial sculpture consisting of growth lines only, periostracal setae and radial ribs absent. Lip of aperture expanded and reflected,

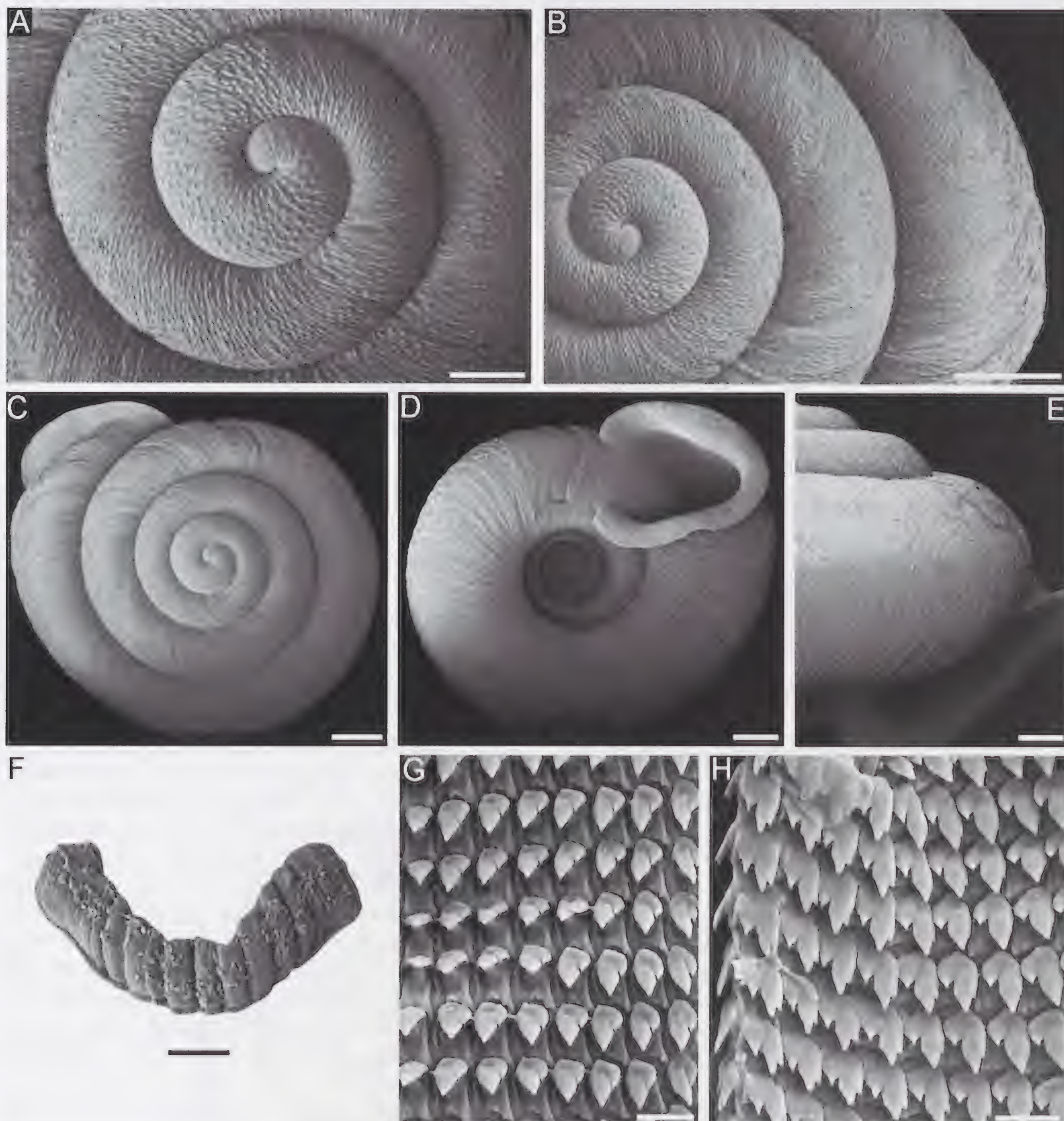


FIG. 112. SEM micrographs of *Baudinella tuberculata* n. sp. (Coronation Island). A–E: Shell paratype AM C471746. A: Apical view showing protoconch and first whorl. Scale bar = 500 μ m; B: Sculpture across entire shell viewed from above; C: Entire shell viewed from above; D: Entire shell viewed from below showing umbilicus and aperture. Scale bars B–D = 1 mm; E: Detail of sculpture on last whorl, lateral view. Scale bar = 500 μ m; F: Jaw paratype AM C471743. Scale bar = 100 μ m; G–H: Radula paratype AM C471743. Scale bars = 20 μ m; G: Central and inner lateral teeth viewed from above; H: Transitional and middle marginal teeth viewed from above.

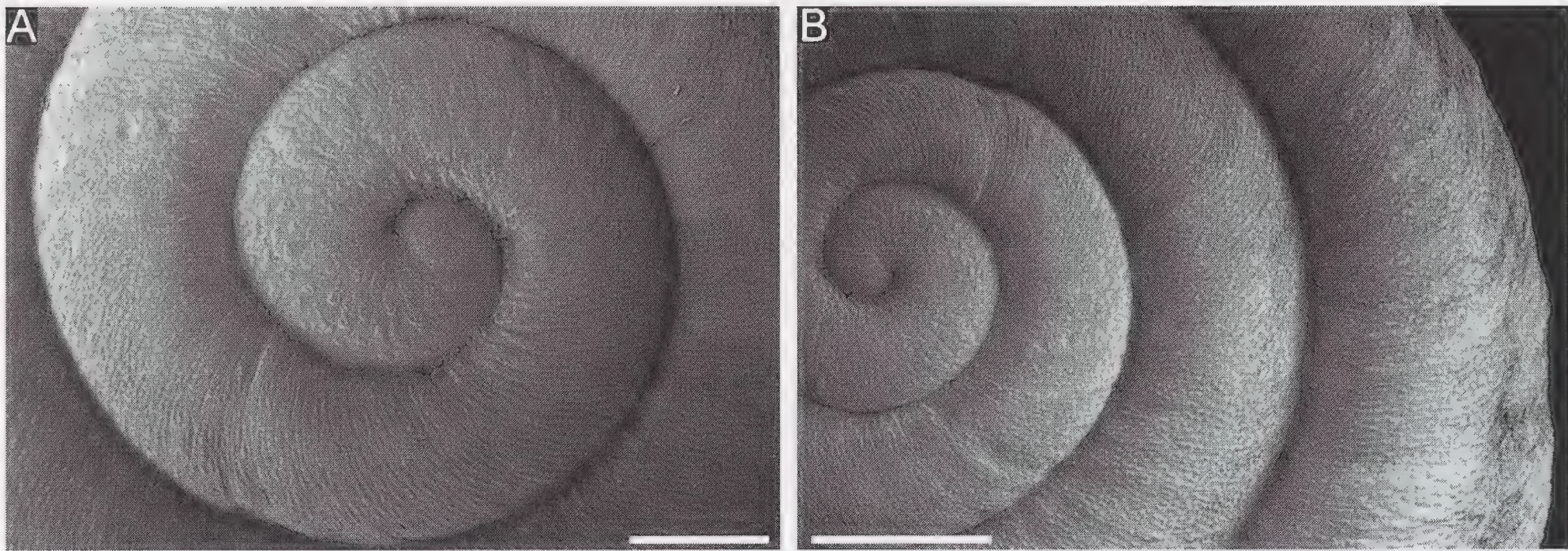


FIG. 113. SEM micrographs of the shell of *Baudinella tuberculata* n. sp. (AM C471747, Malby Island). A: Apical view showing protoconch and first whorl. Scale bar = 500 µm; B: Sculpture across entire shell viewed from above. Scale bar = 1 mm.

thickened; outer palatal and basal nodes very weakly developed, parietal wall inconspicuous.

Digestive anatomy (Fig. 112F–H): Jaw consisting of 14–15 plates ($n = 1$). Radula 1–2 mm long, C + 7–8 + 2–3 + 13–14 ($n = 2$).

Genital anatomy (Figs. 114–115): Penis elongate with slightly inflated proper. Epiphallus well developed, longer than penis, reflected, supporting well-developed epiphallic flagellum; inner epiphallic wall supporting two longitudinal pilasters. Inner penial wall supporting two well-developed, distinct longitudinal pilasters along entire surface tapering anteriorly. Vagina strongly elongated, tubular, longer than penis and much longer than free oviduct. Bursa

copulatrix short, extending anterior end of spermooviduct, head S-folded, attached to base of spermooviduct by connective tissue.

Mitochondrial Differentiation

Intraspecific genetic divergence: 0.0–0.011 (3 sequences); interspecific distances with respect to all other congeners: 0.133–0.160 (7 sequences, 3 species).

Comparative Remarks

Differs from all other species by conspicuous, tuberculate microsculpture of shell, most

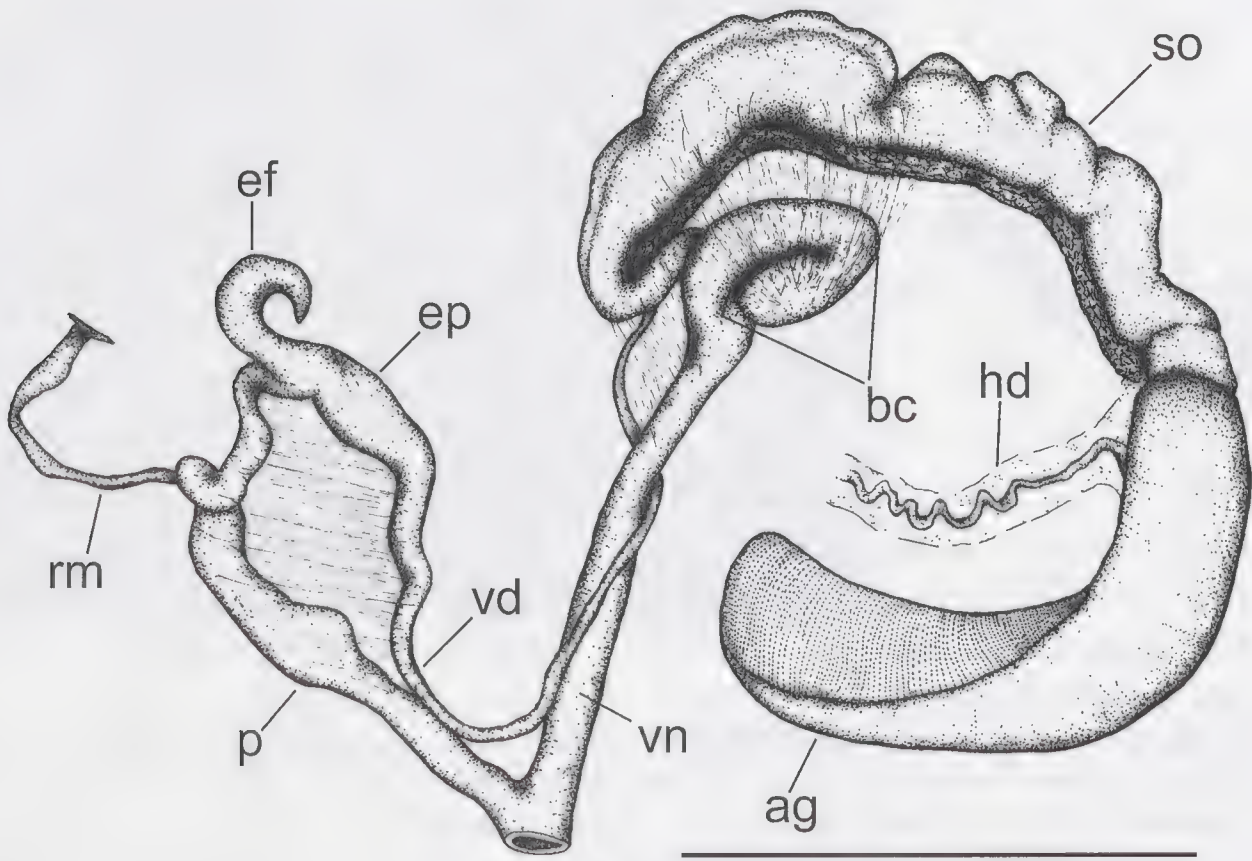


FIG. 114. Genital anatomy of *Baudinella tuberculata* n. sp. holo-type WAM S58444 (Coronation Island, June). Scale bar = 3 mm.

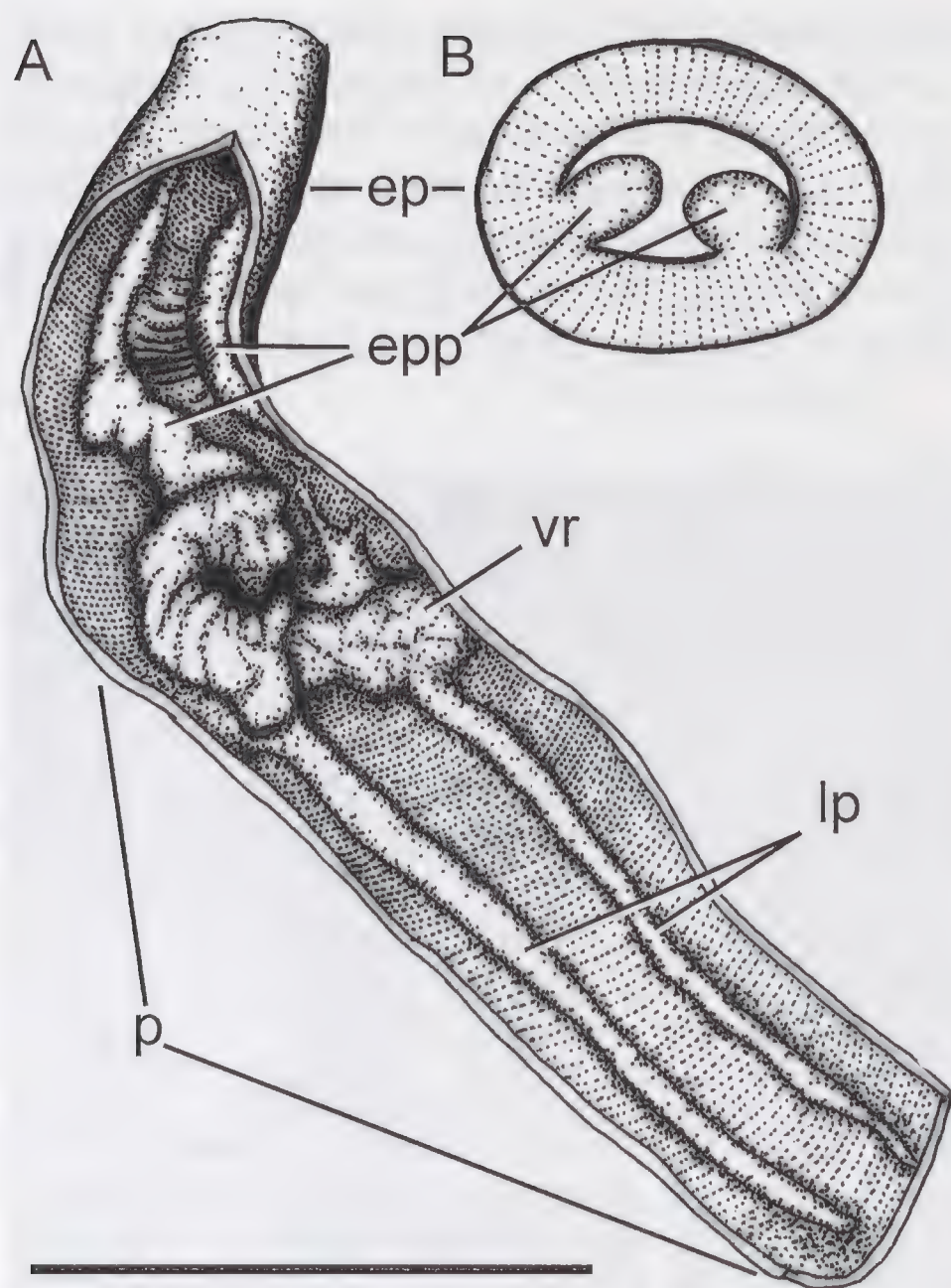


FIG. 115. Penial anatomy of *Baudinella tuberculata* n. sp. holotype WAM S58444 (Coronation Island, June). A: Penial anatomy; B: Schematic cross-section through epiphallus. Scale bar = 1 mm.

strongly elevated spire, and largest H/D ratio (Table 8). Inner penial wall supporting two instead of four longitudinal pilasters as found in *B. boongareensis*. The relatively weak development of apertural nodes and absence of strong radial ribs were previously thought to be diagnostic for *Setobaudinia* (Solem, 1985a, 1991). Differs from *Setobaudinia garlinju* from Coronation Island by smaller size, absence of radial ribs and periostracal setae and more pronounced reflection of apertural lip. Two specimens from Malby Island, about 15 km NW of type locality are considered conspecific although having weaker pustulation (Fig. 113).

Distribution (Fig. 102)

Southern part of Coronation Island (not found in the northern part), and Malby Island, about 15 km in northwesterly direction; in vine thickets.

Baudinella setobaudinioides n. sp.

Figs. 79Q, 116–118

Type Locality

Western Australia, central Kimberley coast, Bonaparte Archipelago, Camden Sound, NW section of Augustus Island, 15°21'05"S, 124°31'47"E; coll. Michael Shea, 22/05/2008, KIS 1–45 (W-facing slope of low sandstone escarpment, scattered vine thicket trees; under rocks in litter).

Material Examined

Holotype WAM S58445 (preserved specimen, dissected). Paratypes AM C471748 (6 preserved specimens), WAM S37035 (13 preserved specimens), WAM S37263 (17 shells) from type locality; WAM S37036 (12 preserved specimens), WAM S37264 (7 shells) from 15°21'06"S, 124°31'48"E; AM C471749 (12 shells), WAM S37265 (20 shells) from 15°21'24"S, 124°31'39"E; WAM S37037 (4 preserved specimens), WAM S37266 (16 shells) from 15°20'16"S, 124°31'16"E; WAM S37038 (18 preserved specimens), WAM S37267 (8 shells) from 15°19'58"S, 124°31'01"E; AM C471750 (10 preserved specimens), WAM S37685 (18 preserved specimens) from 15°20'11"S, 124°31'10"E.

Etymology

Derived from the genus name *Setobaudinia* and the Greek suffix "-oides" (οειδής, an adjective suffix for nouns = like, resemble), for this species exhibiting shell features previously held diagnostic for *Setobaudinia*; adjective of feminine gender.

Description

Shell (Figs. 79Q, 116A–E): Small (D = 7.0 mm on average, Table 8), with low spire. Protoconch with relatively large, sparsely arranged tubercles; extending about one whorl. Teleoconch with regularly spaced but indistinctly developed, radial ribs or growth lines, most prominent on first whorl, microsculpture of dense and fine pustules; periostracal hairs may be present particularly in young specimens. Lip of aperture expanded and reflected, thickened; outer palatal well developed, basal node very weak, parietal wall inconspicuous.

Digestive anatomy (Fig. 116F–H): Jaw consisting of many plates ($n = 1$). Radula ~ 1 mm long, C + 5–6 + 2–3 + 10–12 ($n = 1$).

Genital anatomy (Figs. 117–118): Penis moderately long. Epiphallus well developed, about as long as penis, reflected, supporting a well-developed epiphallic flagellum; inner epiphallic

wall supporting two longitudinal pilasters. Inner penial wall supporting three indistinct longitudinal pilasters that taper anteriorly. Vagina much shorter than penis, inflated. Bursa copulatrix clearly extending anterior end of spermoviduct, head weakly S-folded, attached to base of spermoviduct by connective tissue.

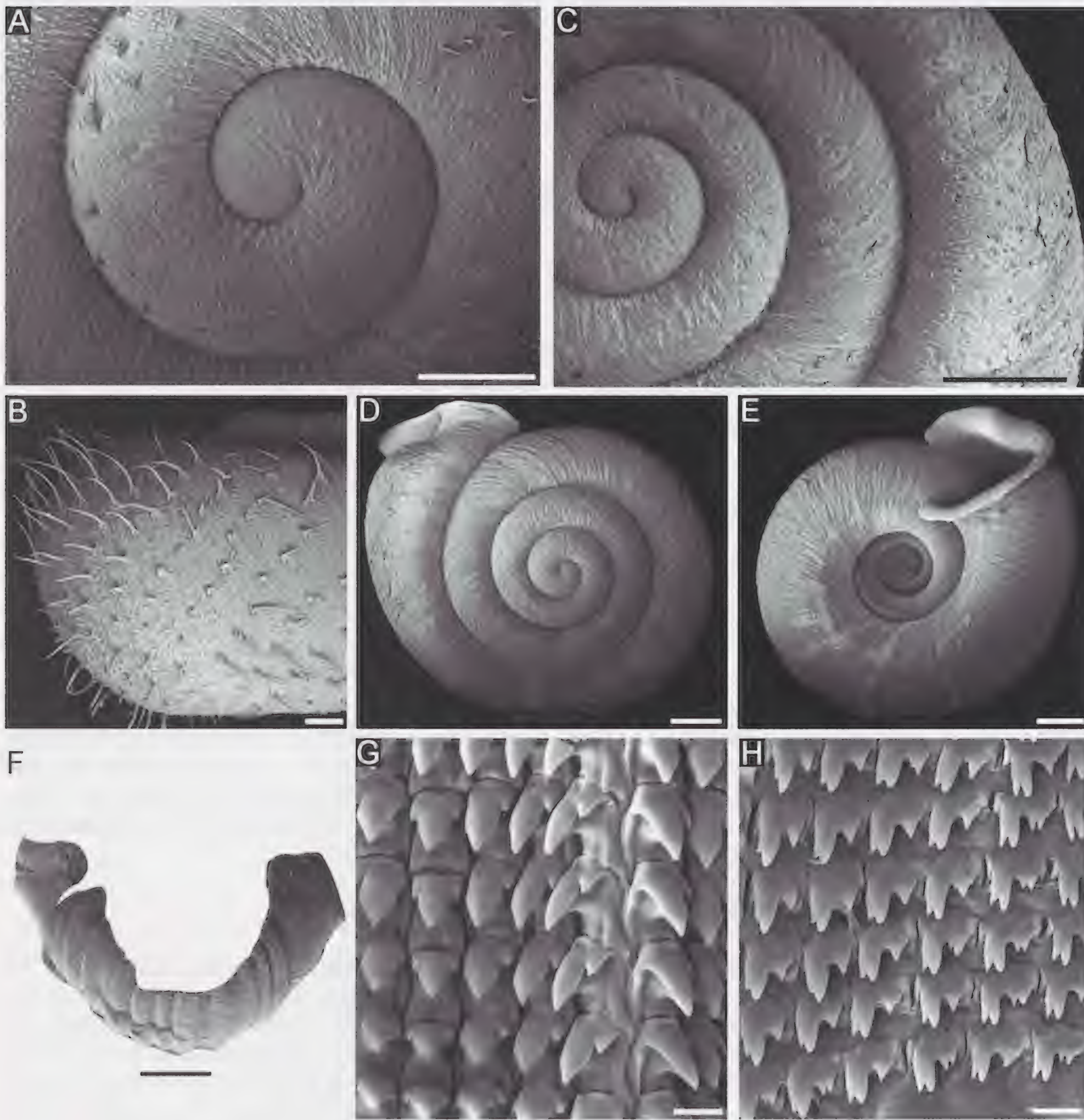


FIG. 116. SEM micrographs of *Baudinella setobaudinioides* n. sp. (Augustus Island). A–B: Shell paratype AM C471749 (juvenile shell with plenty of periostracal hairs). A: Apical view showing protoconch and first whorl. Scale bar = 500 μ m; B: Sculpture across entire shell viewed from above; C–E: Shell paratype AM C471749 (adult shell without periostracal hairs); C: Entire shell viewed from above; D: Entire shell viewed from below showing umbilicus and aperture. Scale bars B–D = 1 mm; E: Detail of sculpture on last whorl, lateral view. Scale bar = 500 μ m; F: Jaw paratype AM C471748. Scale bar = 100 μ m; G–H: Radula paratype AM C471748. Scale bars = 20 μ m; G: Central and inner lateral teeth viewed from above; H: Transitional and middle marginal teeth viewed from above.

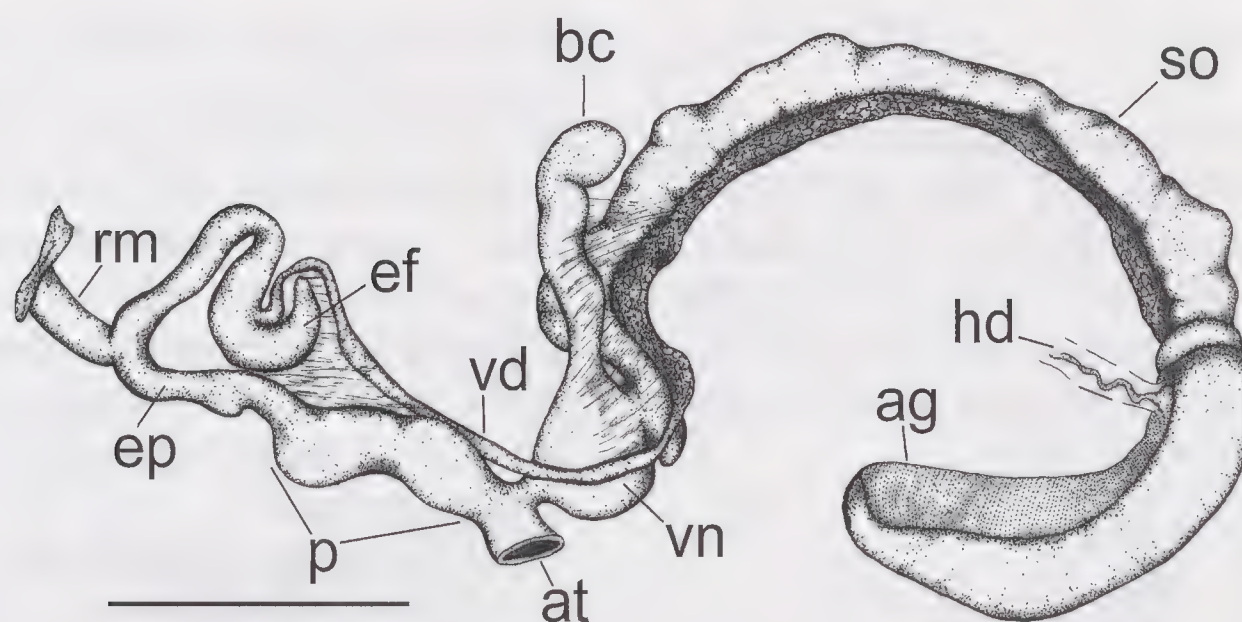


FIG. 117. Genital anatomy of *Baudinella setobaudinioides* n. sp. holotype WAM S58445 (Augustus Island, May). Scale bar = 2 mm.

Mitochondrial Differentiation

Intraspecific genetic divergence: 0.0 (2 sequences); interspecific distances with respect to all other congeners: 0.133–0.160 (8 sequences, 3 species).

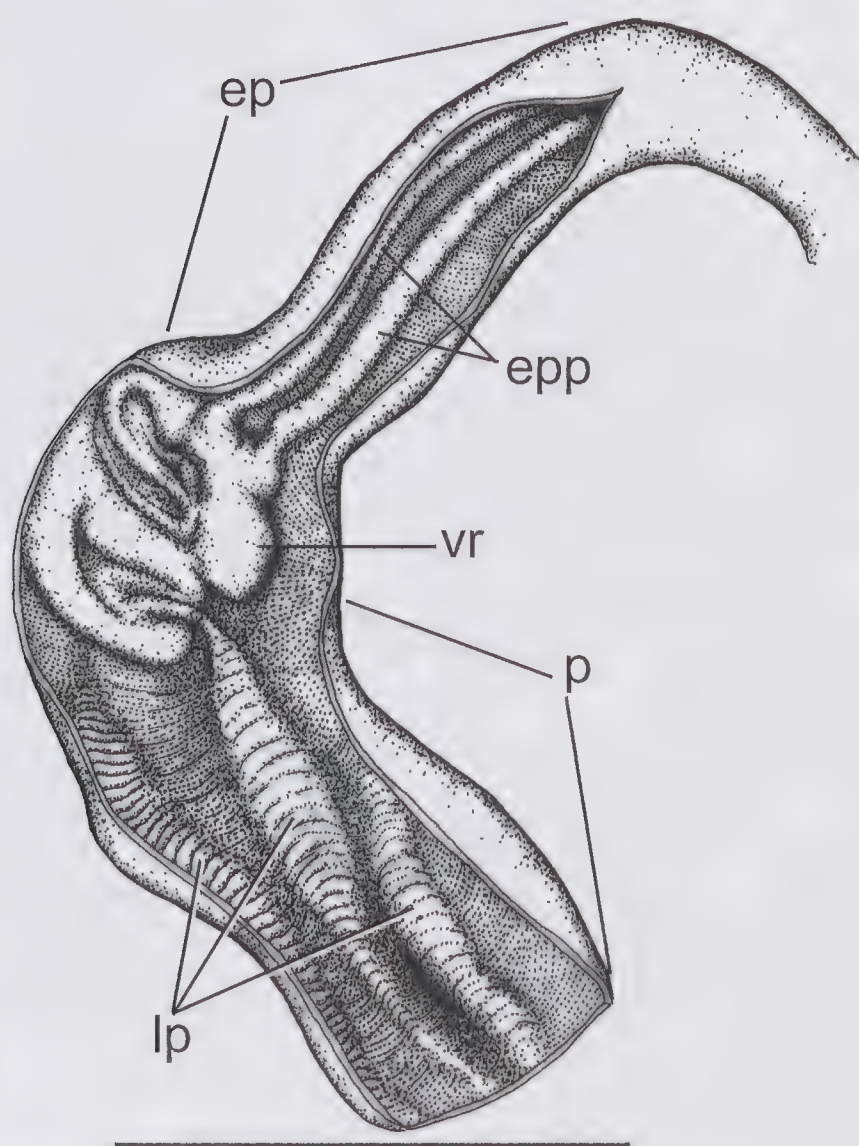


FIG. 118. Penial anatomy of *Baudinella setobaudinioides* n. sp. holotype WAM S58445 (Augustus Island, May). Scale bar = 1 mm.

Comparative Remarks

Differs from *B. baudinensis*, *B. regia* and *B. boongareensis* by weaker radial sculpture, weaker nodes of apertural lip and weaker reflection of apertural lip; from *B. tuberculata* by presence of ribs. Inner penial wall supporting three instead of four longitudinal pilasters like *B. boongareensis*, or two like *B. tuberculata*. The weak apertural nodes and absence of strong radial ribs were thought to be diagnostic for *Setobaudinia* (Solem, 1985a, 1991); material of this species was indeed mistaken as member of *Setobaudinia* as based on the shell. Shell differs from *Setobaudinia* essentially by smaller size. Radula differs from *B. tuberculata* by smaller size having fewer rows of teeth.

Distribution (Fig. 102)

Northwestern part of Augustus Island (not found in the southern part), in vine thickets.

Baudinella occidentalis n. sp.
Figs. 79R, 119–121

Type Locality

Western Australia, central Kimberley coast, Bonaparte Archipelago, northwestern section of D'Arcy Island, 15°15'30"S, 124°25'57"E; coll. Roy Teale, 6/06/2008, KIS 2–58 (small vine thicket behind beach at base of very steep sandstone cliffs; under rocks).

Material Examined

Holotype WAM S58446 (preserved specimen, dissected). Paratypes WAM S37079 (5 preserved specimens), AM C471751 (2 shells), WAM S37262 (7 shells) from type locality; WAM S37694 (2 preserved specimens), AM C471752 (30 shells), WAM S49043 (57 shells) from 15°15'31"S, 124°25'58"E.

Etymology

From "*occidentalis*" (Latin = western) in reference to the fact that this species is at the western-most fringe of the currently known range of *Baudinella*; adjective of feminine gender.

Description

Shell (Figs. 79R, 119): Small ($D = 6.6$ mm on average, Table 8), with flat to low spire.

Protoconch with relatively large, sparsely arranged tubercles; extending about one whorl. Teleoconch with regularly spaced but not very prominent radial ribs, most prominent on first whorl, microsculpture of sparse fine pustules; periostracal hairs may be present particularly in young specimens. Lip of aperture expanded and reflected, thickened; outer palatal well developed, basal node very weak, parietal wall inconspicuous.

Genital anatomy (Figs. 120–121): Penis very short, with inflated proper. Epiphallus longer than penis, winding, supporting small epiphallic flagellum; inner epiphallic wall supporting three longitudinal pilasters. Inner penial wall supporting two well-developed longitudinal pilasters along entire surface that taper anteriorly. Vagina, tubular, elongated, about as long as free oviduct. Bursa copulatrix just extending anterior end of spermoviduct, head unfolded, attached to base of spermoviduct by connective tissue.

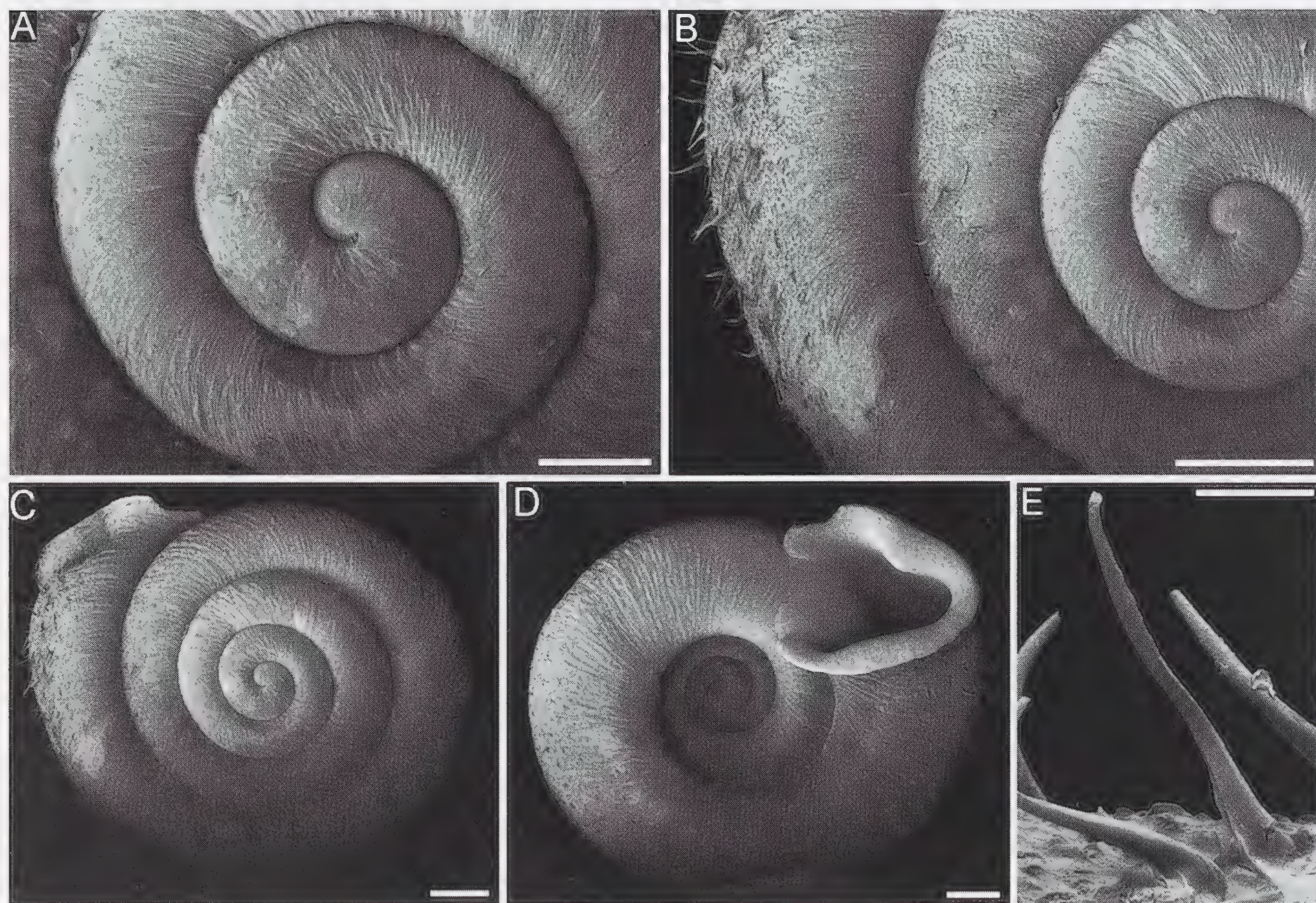


FIG. 119. SEM micrographs of the shell of *Baudinella occidentalis* n. sp. paratype AM C471751 (D'Arcy Island). A: Apical view showing protoconch and first whorl. Scale bar = 500 µm; B: Sculpture across entire shell viewed from above; C: Entire shell viewed from above; D: Entire shell viewed from below showing umbilicus and aperture. Scale bars B–D = 1 mm; E: Close-up of periostracal hairs. Scale bar = 100 µm.

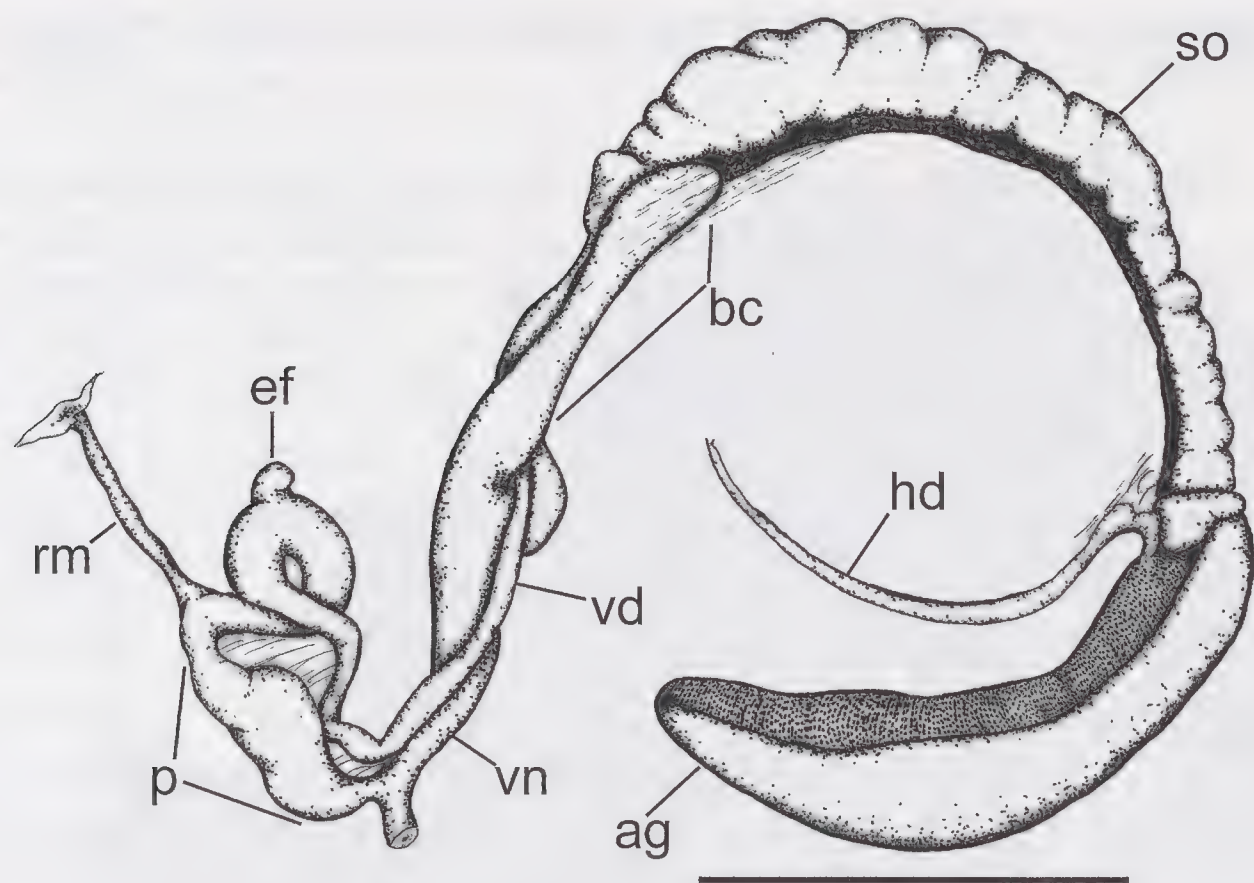


FIG. 120. Genital anatomy of *Baudinella occidentalis* n. sp. holotype WAM S58446 (D'Arcy Island, June). Scale bar = 3 mm.

Mitochondrial Differentiation

Intraspecific genetic divergence: 0.001–0.005 (3 sequences); interspecific distances with

respect to all other congeners: 0.133–0.160 (7 sequences, 3 species).

Comparative Remarks

Smallest of all species treated here (Table 8). Most similar to *B. setobaudinioides* by presence of ribs. Inner penial wall supporting three instead of four longitudinal pilasters like *B. boongareensis*, or two like *B. tuberculata*. Relatively weak apertural nodes and absence of strong radial ribs were thought to be diagnostic for *Setobaudinia* (Solem, 1985a, 1991). Shell differs from *Setobaudinia* essentially by smaller size. Genital anatomy differs from all congeners most conspicuously by presence of three epiphallic pilasters.

Distribution (Fig. 102)

D'Arcy Island, in vine thickets.

Setobaudinia Iredale, 1933

Setobaudinia Iredale, 1933: 55; 1938: 109; 1939: 49–50; Solem, 1985a: 711–775; 1991: 202–207; Solem & McKenzie, 1991: 247–263. Type species: *Helix (Gonostoma) collingii* E. A. Smith, 1893, by original designation.

Taxonomic Remarks

The generic name was erected for the type species, *Helix (Gonostoma) collingii* E. A. Smith, 1893, from Parry Island, Admiralty

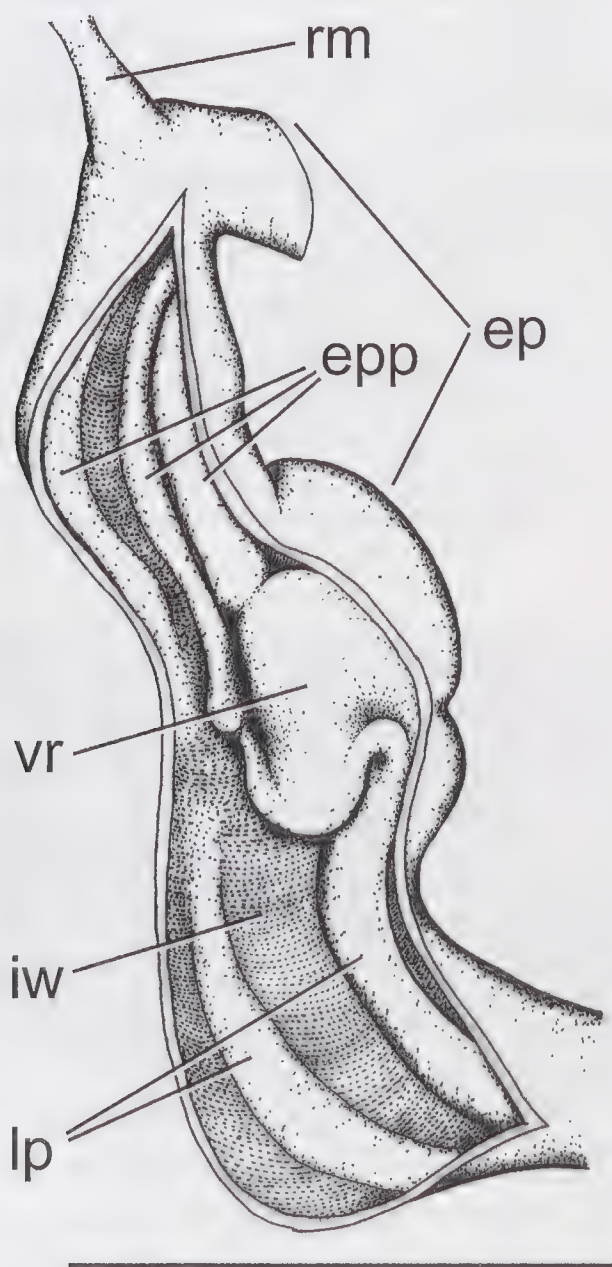


FIG. 121. Penial anatomy of *Baudinella occidentalis* n. sp. holotype WAM S58446 (D'Arcy Island, June). Scale bar = 1 mm.

TABLE 9. Shell parameters of *Setobaudinia* (in mm), given are maximum – minimum (mean ± standard deviation) for N measured specimens.

Species	N	Height (H)	Diameter (D)	Umbilicus (U)	Whorls	H/D Ratio
<i>S. rectilabrum</i>	13	5.2–7.0 (6.1 ± 0.5)	11.2–13.8 (12.4 ± 0.7)	1.8–2.8 (2.1 ± 0.3)	3.7–4.2 (3.9 ± 0.1)	0.45–0.54 (0.50 ± 0.03)
<i>S. herculea</i> n. sp.	7	9.8–10.8 (10.3 ± 0.4)	18.3–20.5 (18.9 ± 0.7)	3.2–3.8 (3.5 ± 0.2)	4.6–4.7 (4.7 ± 0.0)	0.52–0.58 (0.54 ± 0.02)
<i>S. ngurraali</i> n. sp.	15	3.1–3.8 (3.4 ± 0.2)	6.7–7.8 (7.2 ± 0.4)	1.7–2.2 (1.9 ± 0.2)	3.0–3.6 (3.4 ± 0.2)	0.42–0.52 (0.48 ± 0.03)
<i>S. umbadayi</i> n. sp.	13	3.0–3.9 (3.5 ± 0.3)	6.5–8.0 (7.4 ± 0.4)	1.5–2.5 (2.1 ± 0.3)	3.4–3.9 (3.6 ± 0.2)	0.43–0.49 (0.47 ± 0.02)
<i>S. wuyurru</i> n. sp.	10	3.5–4.5 (4.0 ± 0.3)	7.8–8.9 (8.5 ± 0.3)	2.0–3.0 (2.5 ± 0.4)	2.7–3.6 (3.4 ± 0.2)	0.44–0.53 (0.47 ± 0.02)
<i>S. capillacea</i> n. sp.	12	4.1–4.8 (4.4 ± 0.2)	8.3–9.2 (8.8 ± 0.3)	2.2–2.9 (2.5 ± 0.3)	3.5–4.2 (3.9 ± 0.2)	0.45–0.54 (0.50 ± 0.02)
<i>S. garlinju</i> n. sp.	14	3.5–4.6 (4.2 ± 0.3)	7.1–9.4 (8.3 ± 0.6)	1.7–2.2 (1.9 ± 0.2)	2.9–4.0 (3.5 ± 0.3)	0.48–0.53 (0.50 ± 0.02)
<i>S. gumalamala</i> n. sp.	11	3.5–4.2 (4.0 ± 0.2)	7.3–8.2 (7.7 ± 0.3)	1.9–2.1 (2.0 ± 0.1)	3.2–3.7 (3.5 ± 0.1)	0.48–0.57 (0.51 ± 0.02)
<i>S. insolita</i> n. sp.	12	3.8–4.6 (4.1 ± 0.2)	7.5–9.0 (8.3 ± 0.4)	1.7–2.5 (2.1 ± 0.3)	3.5–4.0 (3.6 ± 0.1)	0.45–0.54 (0.49 ± 0.03)
<i>S. quinta</i> n. sp.	17	3.0–4.0 (3.5 ± 0.3)	6.0–7.4 (6.7 ± 0.4)	1.3–2.0 (1.7 ± 0.2)	3.0–3.5 (3.2 ± 0.1)	0.47–0.60 (0.52 ± 0.03)
<i>S. joycei</i> n. sp.	13	3.8–4.8 (4.1 ± 0.2)	7.8–9.0 (8.3 ± 0.4)	2.1–2.7 (2.5 ± 0.2)	3.5–4.0 (3.7 ± 0.1)	0.44–0.61 (0.49 ± 0.04)
<i>S. karczewski</i> {XE “ <i>Setobaudinia</i> <i>karczewskiorum</i> ”} n. sp.	2	3.3–4.0	8.0	2.3	3.3–3.5	0.49–0.50

Gulf (~ 14°19'23"S, 125°46'00"E), with data on its anatomy remaining unavailable. Solem (1985a) revised the taxonomy and described new species. Solem (1991) postulated fairly large ranges for some species, such as *S. collingii* and particularly *S. interrex* (Fig. 122). Based on emerging patterns of narrow range endemism in the Kimberley Camaenidae, I consider this assumption questionable. Since species identifications based only on shell characters are unreliable, the study of preserved material from various locations is required to elucidate species limits and ranges. Combined molecular phylogenetic and anatomical data provide evidence that species currently affiliated with *Damochlora* Iredale, 1938 (*Helix* (*Chloritis*) *rectilabrum* E. A. Smith, 1894), is a

member of *Setobaudinia*. In fact, most, if not all, *Damochlora* species reveal anatomical features typical for *Setobaudinia*. *Damochlora* essentially differs by larger size, which might not be a suitable character to indicate generic distinctiveness. The taxonomic status of *Damochlora* with respect to *Setobaudinia* is pending to be resolved elsewhere through examination of its type species.

Diagnosis

Shell: Small to medium sized (D = 6.0–20.5 mm; Table 9), nearly discoidal with flat to moderately elevated spire; slowly increasing whorls separated by well-incised suture, umbilicus moderately to widely open, not concealed;

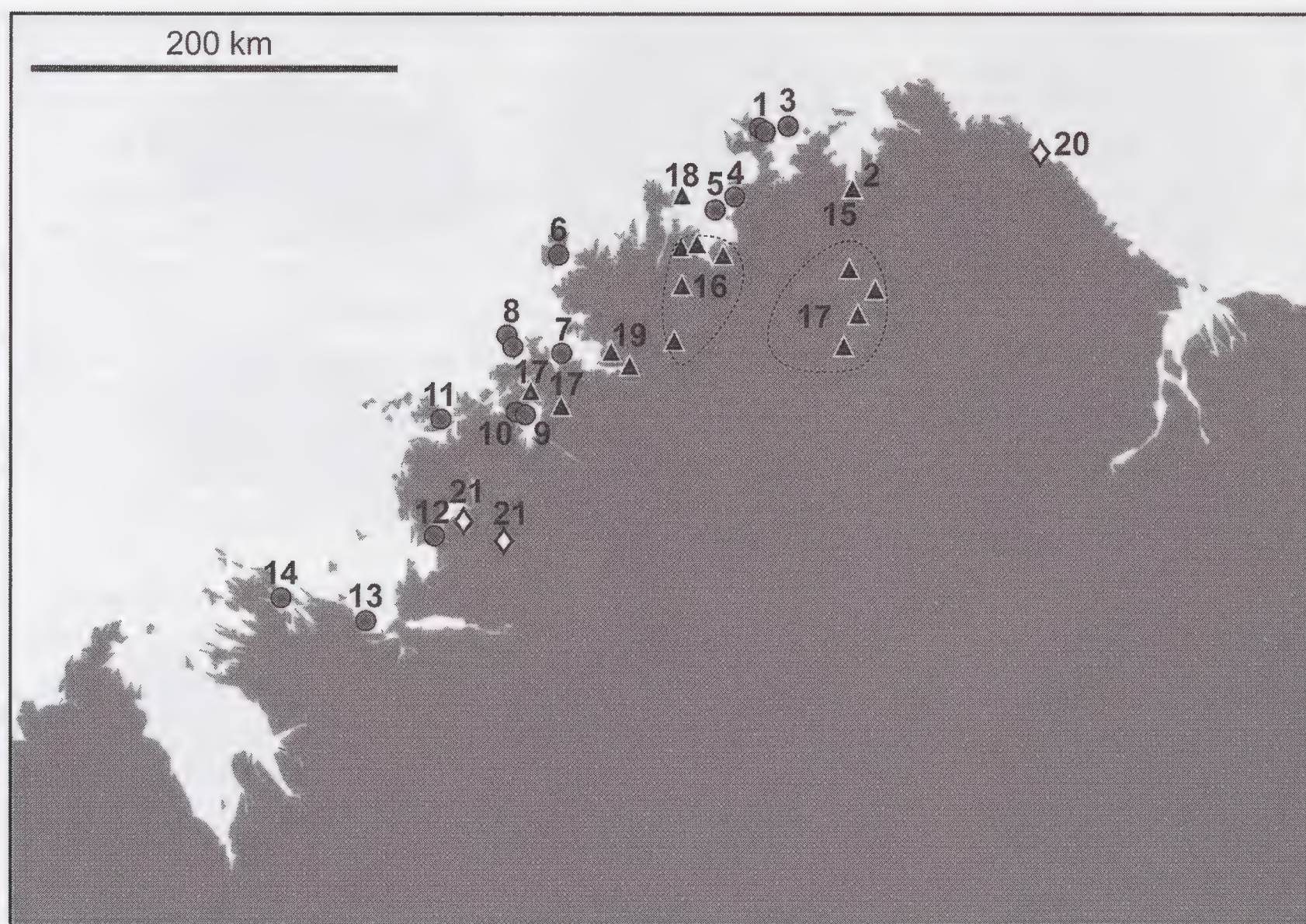


FIG. 122. Distribution map of *Setobaudinia* in the Kimberley. Circles = records of species treated herein: 1: *Setobaudinia rectilabrum* (Bougainville Peninsula, Wargul Wargul Island), 2: *S. kalumburuana* n. sp. (Kalumburu Mission), 3: *S. herculea* n. sp. (Eclipse Hill Island), 4: *S. ngurraali* n. sp. (Middle Osborn Island), 5: *S. umbadayi* n. sp. (Southwest Osborn Island), 6: *S. wuyurru* n. sp. (Bigge Island), 7: *S. capillacea* n. sp. (Boongaree Island), 8: *S. garlinju* n. sp. (Coronation Island), 9: *S. gumalamala* n. sp. (St Andrews Island), 10: *S. insolita* n. sp. (St Patrick Island), 11: *Setobaudinia* sp. (Augustus Island), 12: *S. quinta* n. sp. (Storr Island), 13: *S. joycei* n. sp. (Wulalam Island), 14: *S. karczewski* n. sp. (Molema Island); triangles = records of Solem (1985, 1991): 15: *S. pagoana* Solem, 1985 (near Kalumburu), 16: *S. calvitia* Solem, 1985 and *S. hirsuta* Solem, 1985 (Mitchell Plateau), 17: *S. doongana* Solem, 1985 (Carson River Escarpment), 18: *S. collingii* (Smith, 1893) (Parry Island), 19: *S. interrex* Solem, 1985 (Prince Regent Reserve); diamonds = records of undescribed taxa listed by Solem (1991): 20: *Setobaudinia* NSP6 (near Cape Bernier), 21: *Setobaudinia* NSP5 (Doubtful and Collier Bay area; probably at least partly identical with *S. quinta*).

protoconch with well-developed microsculpture of regularly arranged, rather strongly developed tubercles; teleococonch lacking ribs, usually with very indistinct radial growth lines only, microsculpture of well-developed pustulation that form a regular pattern of parallel radial rows, frequently these projections support short periostracal setae or projections, often lost in adults, pustulation continuing on inner umbilical whorls; body whorl slightly to moderately descending, periphery well rounded. Shell colour uniform, yellowish brown to brown. Lip of aperture expanded, basal and palatal edges may be curved, outer palatal and basal nodes weak or absent, parietal wall inconspicuous.

Genital anatomy and head wart: Head with eversible head wart opening between and

just posterior to ommatophores. Penis well developed, thick penial sheath extending entire length from insertion of retractor muscle to just above atrium; epiphallus well developed, tightly connected to penis by connective tissue, usually with well-developed epiphallic flagellum and epiphallic lobe. Inner penial wall completely covered with dense pustulation, pustules may be conspicuously laterally elongated or replaced by transverse pilasters or lateral lamellae, particularly at distal portion of penial wall, towards the proximal end, pustules often taper in size and shape. Most proximal part of penial wall usually weak; may become entirely dissolved resulting in detachment of the penis from the atrium (see Fig. 149, for instance). Penial retractor muscle attached

at epiphallus near connection with penial complex. Epiphallus opens to penial lumen through large, conical verge with gutter forming along its tip. Inner epiphallic wall covered by characteristic armature of longitudinal ridges or pilasters and/or pustulation; vas deferens opens into epiphallus through slit-like, valvular opening. Free oviduct short, bent into S-shape. Bursa copulatrix elongated, tubular, extending to anterior end of albumen gland.

Aestivation Strategy

Free sealer (modified after Solem, 1985a).

Comparative Remarks

Species of *Setobaudinia* are readily distinguished from all other Kimberley camaenids except *Baudinella* by their usually small size, discoid shell, wide umbilicus, and typical pattern of microscopic periostracal projections; see above for comparison with *Baudinella*. Species subsumed under *Damochlora* are very similar in shell morphology and, where known, genital anatomy, differing essentially by larger size. However, some *Setobaudinia* species are exceptionally large, with shell diameter at magnitude of centimetres. Weakening or dissolution of posterior part of penial wall and partial or entire detachment of penis from atrium is a feature observed herein for the first time in any Australian camaenid. The functional significance of this detachment is unknown but believed to relate to a certain stage in reproductive development. Further typical combination of genital characteristics is presence of well-developed penial sheath, well-developed epiphallus with epiphallic flagellum and epiphallic lobe, large penial verge. These features are either not as well developed or absent in *Baudinella*, *Molema* and *Torresitrachia*. Shells of some species of *Torresitrachia* can be similar. Most conspicuously, they differ by a distinct microsculpture of the protoconch. The teleoconch of *Setobaudinia* differs by absence of well-developed axial ribs (usually present in the latter) and presence of periostracal pustulation or even hairs (usually absent in *Torresitrachia*). However, development of these microscopic features may vary considerably within both groups and may be difficult to detect in adult shells with worn periostracum.

Diversity and Distribution (Fig. 122)

Setobaudinia species are found along almost the entire Kimberley coast from Kalumburu in the

north to near Derby in the south, including many islands. They are confined to rainforest patches and vine thickets. Solem (1985a, 1991) listed nine species, including undescribed taxa. In addition, 12 species are described herein from various islands of the Bonaparte and Buccaneer archipelagos between the Eclipse Archipelago in the north and Molema and Wulalam islands in the south. An additional species is transferred to *Setobaudinia* from *Damochlora*; one supposedly undescribed species from southern section of Augustus Island is known from a dry shell, which does not permit formal description (WAM S37274).

Setobaudinia rectilabrum
(E. A. Smith, 1894) n. comb
Figs. 123A, 124–126

Helix (Cloritis) rectilabrum E. A. Smith, 1894: 88, pl. VII, fig. 11.

Damochlora rectilabrum – Iredale, 1938: 98 (not Solem, 1979: 111–113; 1991: 185; Solem & McKenzie, 1991: 247–263).

Type Locality

Parry Harbour, northwestern Australia (Bougainville Peninsula).

Type Material

Lectotype BMNH 92.1.29.19 (shell); paralectotypes BMNH 92.1.29.20–1 (2 shells) (not examined).

Material Examined

WAM S49360 (2 preserved specimens), AM C471822 (5 shells), WAM S49345 (8 shells) from Bougainville Peninsula, Vansittart Bay, 13°55'58"S, 126°08'53"E; WAM S49339 (preserved specimen), WAM S49365 (6 preserved specimens), WAM S49361 (11 preserved specimens), AM C471826 (5 preserved specimens), AM C471823 (12 shells), AM C471824 (6 shells), AM C471825 (9 shells), WAM S49339 (12 shells), WAM S49340 (30 shells), WAM S49341 (18 shells), WAM S49342 (6 shells), WAM S49343 (2 shells), WAM S49344 (18 shells) from Wargul Wargul Island, Vansittart Bay, about 1.5 km W of Bougainville Peninsula.

Taxonomic Remarks

This species was described based on dry shell material from Parry Harbour, northwestern part of Bougainville Peninsula (~ 14°00'S, 126°00'E).

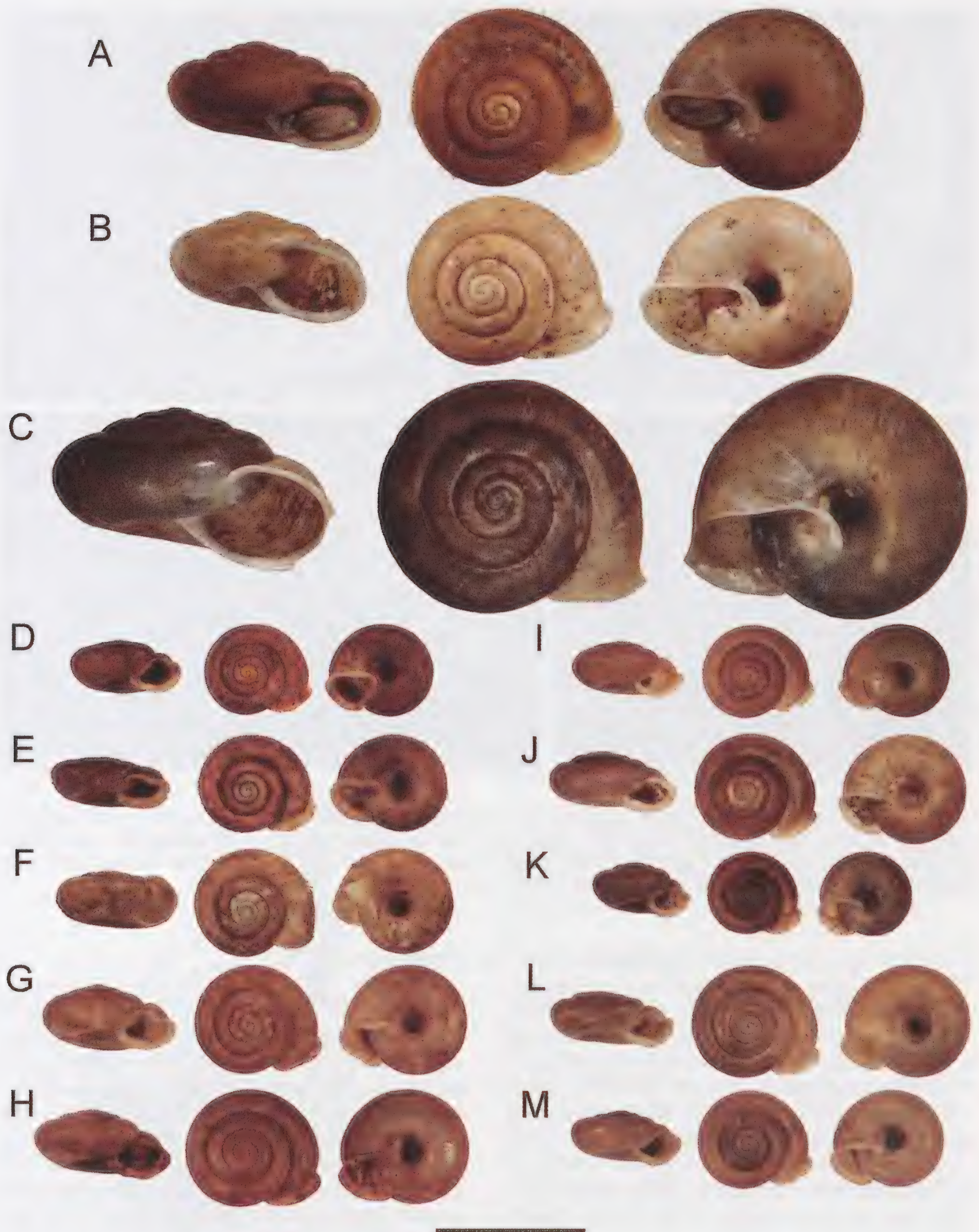


FIG. 123. Shells of *Setobaudinia*. A: *Setobaudinia rectilabrum* WAM S49361 (Wargul Wargul Island); B: *Setobaudinia kalumburuana* n. sp. paratype AM C106527 (Kalumburu); C: *Setobaudinia herculea* n. sp. paratype WAM S49346 (Eclipse Hill Island); D: *Setobaudinia ngurraali* n. sp. paratype WAM S36370 (Middle Osborn Island); E: *Setobaudinia umbadayi* n. sp. paratype WAM S36380 (Southwest Osborn Island); F: *Setobaudinia wuyurru* n. sp. paratype WAM S36352 (Bigge Island); G: *Setobaudinia capillacea* n. sp. paratype WAM S36361 (Boongaree Island); H: *Setobaudinia garlinju* n. sp. paratype WAM S33367 (Coronation Island); I: *Setobaudinia gumalamala* n. sp. paratype WAM S37268 (St Andrew Island); J: *Setobaudinia insolita* n. sp. paratype WAM S49044 (St Patrick Island); K: *Setobaudinia quinta* n. sp. paratype WAM S37889 (Storr Island); L: *Setobaudinia joycei* n. sp. paratype WAM S37885 (Wulalam Island); M: *Setobaudinia karczewski* n. sp. paratype WAM S37887 (Molema Island). Scale bar = 10 mm.

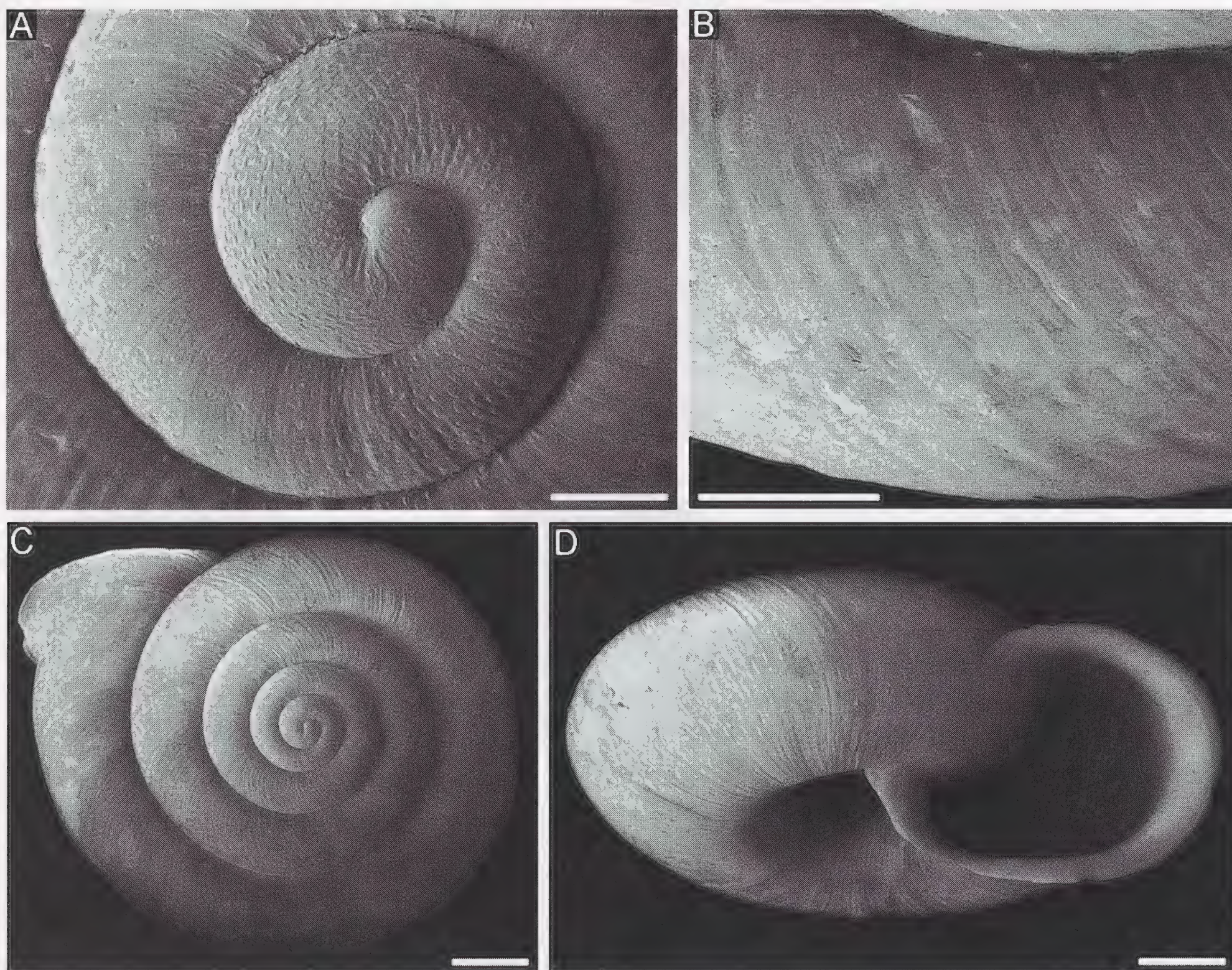


FIG. 124. SEM micrographs of the shell of *Setobaudinia rectilabrum* AM C471824 (Wargul Wargul Island). A: Apical view showing protoconch and first whorl. Scale bar = 500 μ m; B: Close-up of sculpture on last whorl. Scale bar = 1 mm; C: Entire shell viewed from above; D: Entire shell viewed obliquely from below showing aperture. Scale bars C–D = 1 mm.

The lectotype has been designated by Solem (1979). Affiliated with *Damochlora* by Iredale, 1938, which was followed by Solem (1979, 1991), who published anatomical description based on examination of material from south of Kalumburu, Kimberley mainland ($\sim 14^{\circ}18'S$, $126^{\circ}39'E$), about 70 km SE from type locality. Material studied here from Bougainville Peninsula ($\sim 13^{\circ}56'S$, $126^{\circ}08'E$), immediately south of the type locality, revealed morphological features distinct from those described by Solem (1979: fig. 22). Based on this material, anatomy of the present species is redescribed. By contrast, Solem's (1979: 111–113) description of material from Kalumburu refers to an undescribed species, which is named below. *Helix rectilabrum* is transferred to *Setobaudinia* for showing features typical for this taxon. Treatment corroborated by mitochondrial phylogeny, in which all *Setobaudinia* species form a clade (Köhler, unpubl. data).

Description

Shell (Figs. 123A, 124): Large compared to most other congeners ($D = 12.4$ mm on average; Table 9), with low to weakly elevated spire; periphery well rounded to slightly angulated; umbilicus ~ 2 mm wide; colour light brownish-horn. Protoconch ~ 1.7 mm in diameter, comprising about one whorl, with dense radially arranged pustulation. Teleoconch with faint, regular radial growth lines extending onto base of shell and into umbilicus, inner umbilical whorls with periostracal extensions; close-up images reveal traces of sparsely distributed, radially arranged periostracal pustules or extensions, which are worn off in adult shells. Last whorl not or weakly descending behind aperture; angle of aperture $\sim 60^{\circ}$; apertural lip sharp, well expanded, slightly reflected, slightly flattened at base, without nodes, parietal wall delicate.

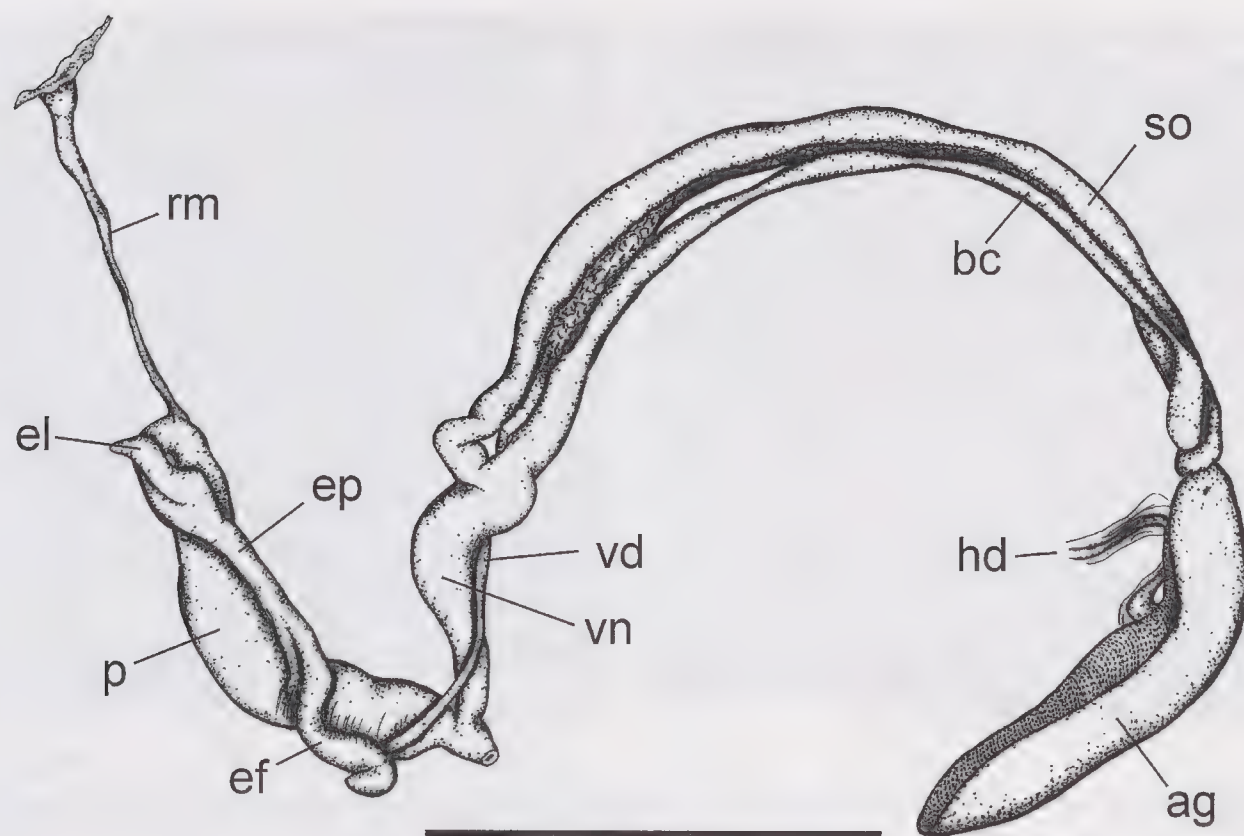


FIG. 125. Genital anatomy *Setobaudinia rectilabrum* AM C471826 (Wargul Wargul Island, June). Scale bar = 5 mm.

Genital anatomy (Figs. 125–126): Penis longer than vagina, rather straight. Epiphallus elongate, bent, more or less same length as penis, tightly connected to penis by connective tissue, with moderately long epiphallic flagellum, well-developed epiphallic lobe at opposite end. Interior

penial wall completely covered with dense pustulation, pustules densely arranged in honeycomb pattern, large, triangular in shape, elevated; at distal portion pustules are laterally extended, longitudinally compressed, more densely packed giving rise to lateral lamellae at very distal end of wall. In the dissected specimen, penis detached from atrium through dissolved penial wall; connected to atrium by proximally thick penial sheath only. Inner epiphallic wall covered with very fine, densely packed longitudinal ridges, some of which give rise to elongated pustules. Penial retractor muscle long. Vagina longer than free oviduct, tubular to posteriorly expanded.

Comparative Remarks

Shell similar to *Torresitrachia*, differing only by microscopic features of protoconch and teleoconch sculpture. Differs from most congeneric species by large size and rather smooth shell sculpture (but see below). Corresponding detachment of penis depicted by Solem (1979) for "*Damochlora rectilabrum*" = ***Setobaudinia kalumburana***; also found in ***S. insolita*** from St. Patrick Island (see below). Penial detachment has only been observed in three species of *Setobaudinia* is considered typical characteristic of the genus. Not observed in all species of the genus; may relate to a certain reproductive stage of individuals.

Distribution (Fig. 122)

Northern portion of Bougainville Peninsula.

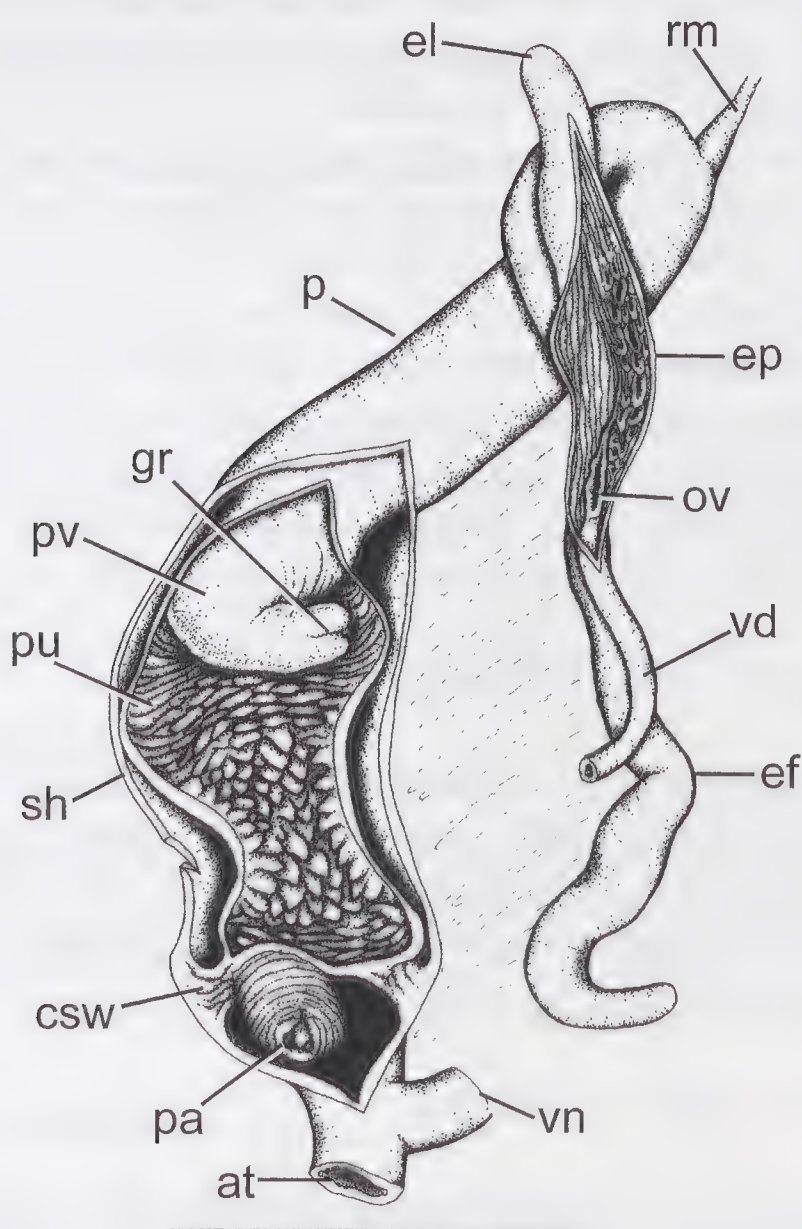


FIG. 126. Penial anatomy of *Setobaudinia rectilabrum* AM C471826 (Wargul Wargul Island, June). Scale bar = 2 mm.

***Setobaudinia kalumburuana* n. sp.**
Fig. 123B

Damochlora rectilabrum – Solem, 1979: 111–113; 1991: 185; Solem & McKenzie, 1991: 247–263 (not *Helix* (*Cloritis*) *rectilabrum* E. A. Smith, 1894).

Type Locality

Western Australia, northwestern Kimberley, cliffs east of Kalumburu Mission, 14°18'S, 126°41'E; coll. P. Coleman, 12/06/1986 (dense rock scree on sandstone cliffs).

Material Examined

Holotype AM C150786 (preserved specimen). Paratypes AM C150786 (11 preserved specimens) from type locality; WAM 621.77 (preserved specimen, dissection by Solem, 1979) from NW-facing cave, 6.5 km S of Kalumburu Mission; AM C106527 (shell; Fig. 123A) from near Kalumburu Mission.

Additional, non-type material AM C133663 (shell), FMNH 199504, FMNH 199508, FMNH 200341, FMNH 200342, FMNH 200342, FMNH 200675, WAM S5103 (was WAM 359.77), WAM S5105 (was WAM 185.79) all from Kalumburu Mission area.

Etymology

For Kalumburu Reserve, adjective of feminine gender.

Taxonomic Remarks

Solem (1979) based anatomical description of “*Damochlora rectilabrum* E. A. Smith, 1894”, on material collected near Kalumburu (WAM 621.77), which is evidently not conspecific with the species named by Smith (1894) from Parry Harbour and described above. Anatomical drawings depicted by Solem (1979: fig. 11; pl. 8a–c) reveal features different from *S. rectilabrum*. Material from around Kalumburu Mission is therefore considered to represent a distinct species, which herein is named ***Setobaudinia kalumburuana***. Like the genuine *S. rectilabrum* (E. A. Smith, 1894), this species is placed within *Setobaudinia* for revealing typical features of this genus. Because the specimen dissected by Solem (1979) could not be traced in collections of FMNH (Jochen Gerber, pers. comm.) and WAM (Corey Whisson, pers. comm.), here another specimen from

Kalumburu is designated as holotype, which corresponds in anatomy with Solem's (1979) description. Molecular evidence from mitochondrial sequences of the AM type series corroborates distinct status of ***S. kalumburuana*** with respect to all other congeners.

Description

Shell (Fig. 123B): Large compared to other *Setobaudinia* species ($D = 12.3$ mm on average; Solem, 1979: 112), with low to weakly elevated spire; periphery well rounded to slightly angulated; umbilicus ~ 2 mm wide; colour light brownish-horn. Protoconch comprising about one whorl, with dense, radially arranged pustulation (Solem, 1979: pl. 8a–c). Teleoconch with faint, regular radial growth lines extending onto base of shell, replaced by microscopic hairs within umbilicus; microsculpture of short, radially arranged periostracal pustules and tiny ridglets, may be worn in adult shells. Last whorl not or weakly descending behind aperture; angle of aperture ~ 60°; apertural lip sharp, well expanded, slightly reflected, slightly flattened at base, without nodes, parietal wall delicate (adapted from Solem, 1979: 111–113).

Genital anatomy (illustrated by Solem, 1979: 102, fig. 22): Penis very long, coiled. Epiphallus moderate in size, bent, shorter than penis, with long epiphallic flagellum and well-developed epiphallic lobe at opposite end. Interior penial wall with dense rectangular pustules arranged in vertical rows, pustules replaced by lateral lamellae at very distal end of wall. Inner epiphallic wall covered with very fine, densely packed pustules arranged in longitudinal rows, anterior end near opening to penial lumen with fine longitudinal ridges. Penial retractor muscle moderately long. Vagina longer than free oviduct, tubular to posteriorly expanded.

Mitochondrial Differentiation

Interspecific genetic distances (1 sequence): 0.143–0.146 with respect to *S. rectilabrum* (2 sequences), 0.13 to ***S. herculea***, 0.147–0.185 to remaining congeners (31 sequences, 10 species).

Comparative Remarks

Shell not readily to be distinguished from *S. rectilabrum*; the latter stated by Solem (1979) to have an angulated periphery, which I cannot confirm as a general feature. Genital anatomy differs most conspicuously by arma-

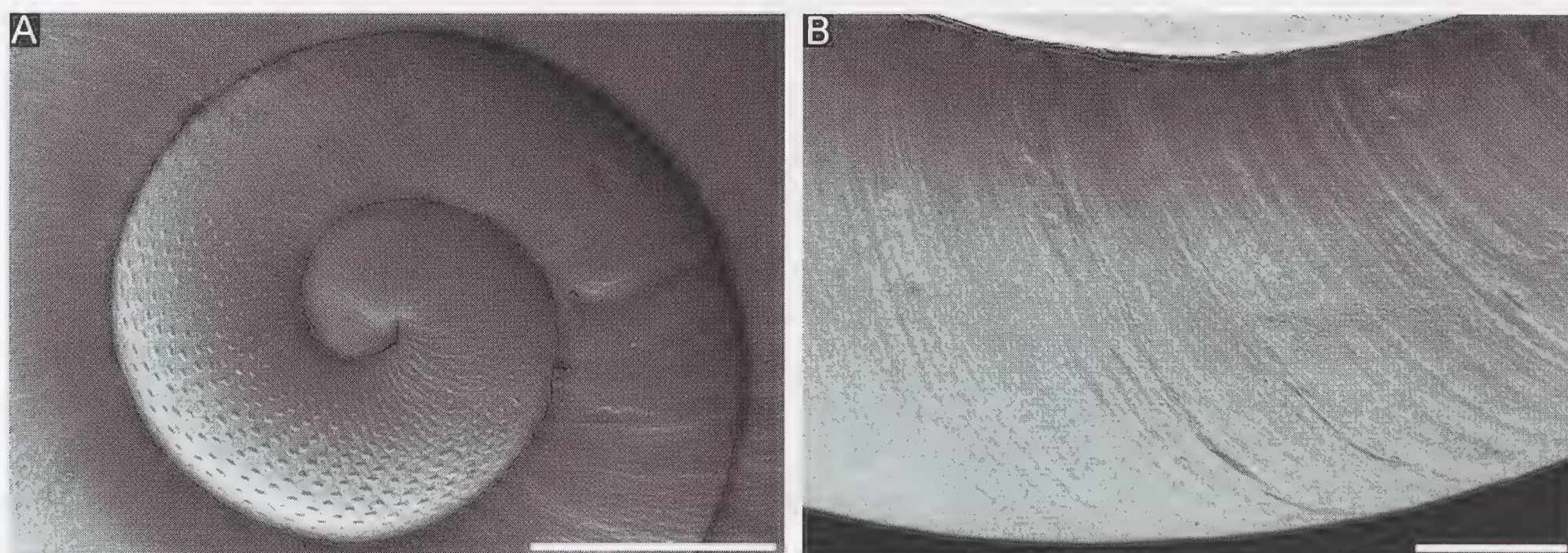


FIG. 127. SEM micrographs of the shell of *Setobaudinia herculea* n. sp. paratype AM C471827 (Eclipse Hill Island). A: Apical view showing protoconch and first whorl; B: Close-up of sculpture on last whorl. Scale bars = 1 mm.

ture of penial and epiphallic walls, penial wall pustules rectangular instead of triangular in *S. rectilabrum*; inner epiphallic wall with pustules instead of longitudinal ridges in *S. rectilabrum*. For comparison with *S. herculea*, another species with similar shell see below. All other congeners differ most conspicuously by much smaller size of shell.

Distribution (Fig. 122)

Mainland, around Kalumburu Mission.

***Setobaudinia herculea* n. sp.**
Figs. 123C, 127, 128

Type Locality

Western Australia, northern Kimberley, Vansittart Bay, Eclipse Archipelago, Eclipse Hill Island, 13°56'31"S, 126°17'01"E; coll. Vince Kessner, 04/06/2010, KIS 3–198 (vine thicket on upper slopes, laterite; under rocks).

Material Examined

Holotype WAM S58470 (preserved specimen). Paratypes WAM S49353 (5 preserved specimens), AM C471827 (3 shells), WAM S49346 (6 shells) from type locality.

Etymology

Derived from "*herculeus*" (Latin = herculean), in reference to its unusually large size; adjective of feminine gender.

Description

Shell (Figs. 123C, 127): Very large compared to other congeners (D = 18.9 mm on average; Table 9) with weakly elevated spire; well-rounded to slightly angulated periphery; umbilicus on average 3.5 mm wide; colour light brownish-horn. Protoconch ~ 2.2 mm in diameter, comprising ~ 1.2 whorls, with regular, radially arranged pustulation. Teleoconch with faint, regular radial growth lines extending onto base of shell and into umbilicus, inner umbilical whorls with periostracal extensions; close-up images reveal traces of sparsely distributed, radially arranged periostracal pustules or extensions; worn in adult shells. Last whorl not or weakly descending behind aperture; angle of aperture ~ 60°; aperture wide, with sharp, flaring, slightly reflected lip, flattened at base, without nodes or only trace of basal node, parietal wall delicate.

Genital anatomy (Fig. 128): Penis longer than vagina, rather straight. Epiphallus elongate, bent, more or less same length as penis, tightly connected to penis by connective tissue, with very long epiphallic flagellum and well-developed epiphallic lobe. Interior penial wall completely covered with dense pustulation, pustules arranged in longitudinal rows, large, triangular in shape, elevated; no traces of transverse lamellae at distal end. Inner epiphallic wall covered with well-developed longitudinal pilasters, replaced by crowded, irregularly shaped pustules within epiphallic lobe. Penial retractor muscle long. Vagina longer than free oviduct, tubular to posteriorly expanded.

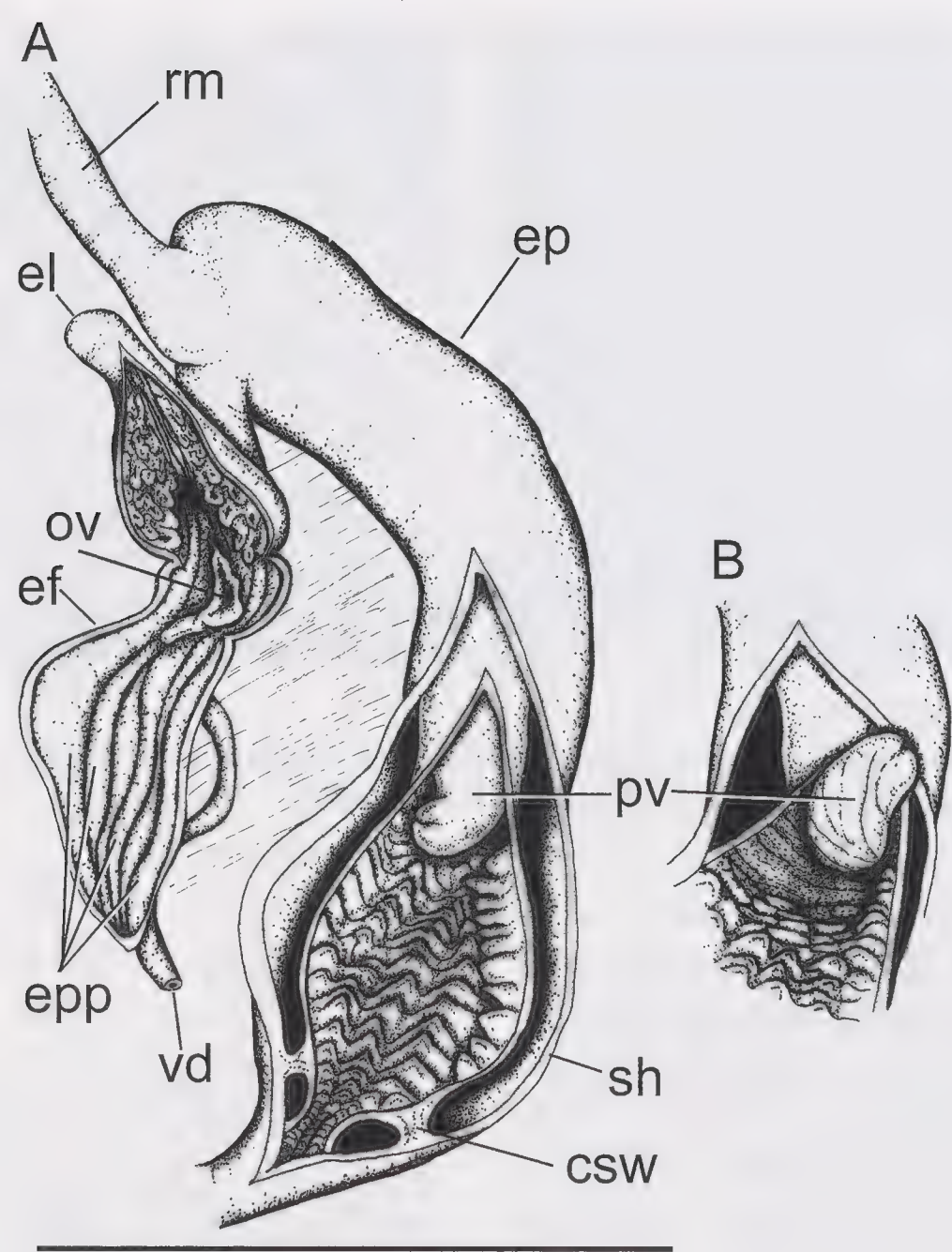


FIG. 128. Penial anatomy of *Setobaudinia herculea* n. sp. paratype WAM S49353 (Eclipse Hill Island, June). Scale bar = 4 mm.

Mitochondrial Differentiation

Interspecific genetic distances (1 sequence): 0.07–0.071 with respect to *S. rectilabrum* (2 sequences), 0.13 to *S. kalumburuana*, 0.147–0.185 to remaining congeners (31 sequences, 10 species).

Comparative Remarks

For comparison with *Torresitrachia*, see general remarks under genus. Shell similar to *S. rectilabrum* and *S. kalumburuana* but considerably larger, with wider aperture and more strongly expanded lip. Characteristic features of genital anatomy are penial wall with triangular pustules arranged in longitudinal rows (honeycomb pattern in *S. rectilabrum*), no transverse lamellae or ridges (like in *S. rectilabrum* and *S. kalumburuana*), penial verge proportionally smaller than in former two species. Proximal end of penis not found to be detached from atrium wall but corresponding portion being narrow and thin indicating similarities with above described features.

Distribution (Fig. 122)

Eclipse Hill Island, Eclipse Archipelago.

Setobaudinia ngurraali n. sp.
Figs. 123D, 129–131

Type Locality

Western Australia, NW Kimberley, Bonaparte Archipelago, Admiralty Gulf, Middle Osborn Island, 14°18'43"S, 126°01'41"E; coll. Vince Kessner, 9/02/2008, KIS 2–28 (vine thicket adjacent to a creek with boulders; in leaf litter).

Material Examined

Holotype WAM S58471 (preserved specimen). Paratypes WAM S36898 (preserved specimen), WAM S36945 (10 shells), WAM S36944 (70 shells), AM C471828 (30 shells), WAM S36366 (8 shells), WAM S58472 (2 preserved specimens), WAM S36714 (9 preserved specimens), WAM S36367 (3 shells), WAMS 36368 (3 shells), WAM S36369 (6 shells), WAM

S36370 (23 shells) from east coast of Middle Osborn Island.

Additional, non-type material. WAM S36371 (6 shells), WAM S36385 (7 shells), WAM S36714 (9 preserved specimens), WAM S36715 (2 preserved specimens), WAM S36716 (preserved specimen), WAM S36717 (6 preserved specimens), WAM S36718 (5 preserved specimens), WAM S36899 (preserved specimen), WAM S58473 (6 preserved specimens) from east coast of Middle Osborn Island.

Etymology

For Ngurraali, name of Middle Osborn Island in Gaambera, language of the Unguu people; noun in apposition.

Description

Shell (Figs. 123D, 129): Small ($D = 7.2$ mm on average; Table 9), with low to weakly elevated spire; last whorl slightly angulated above periph-

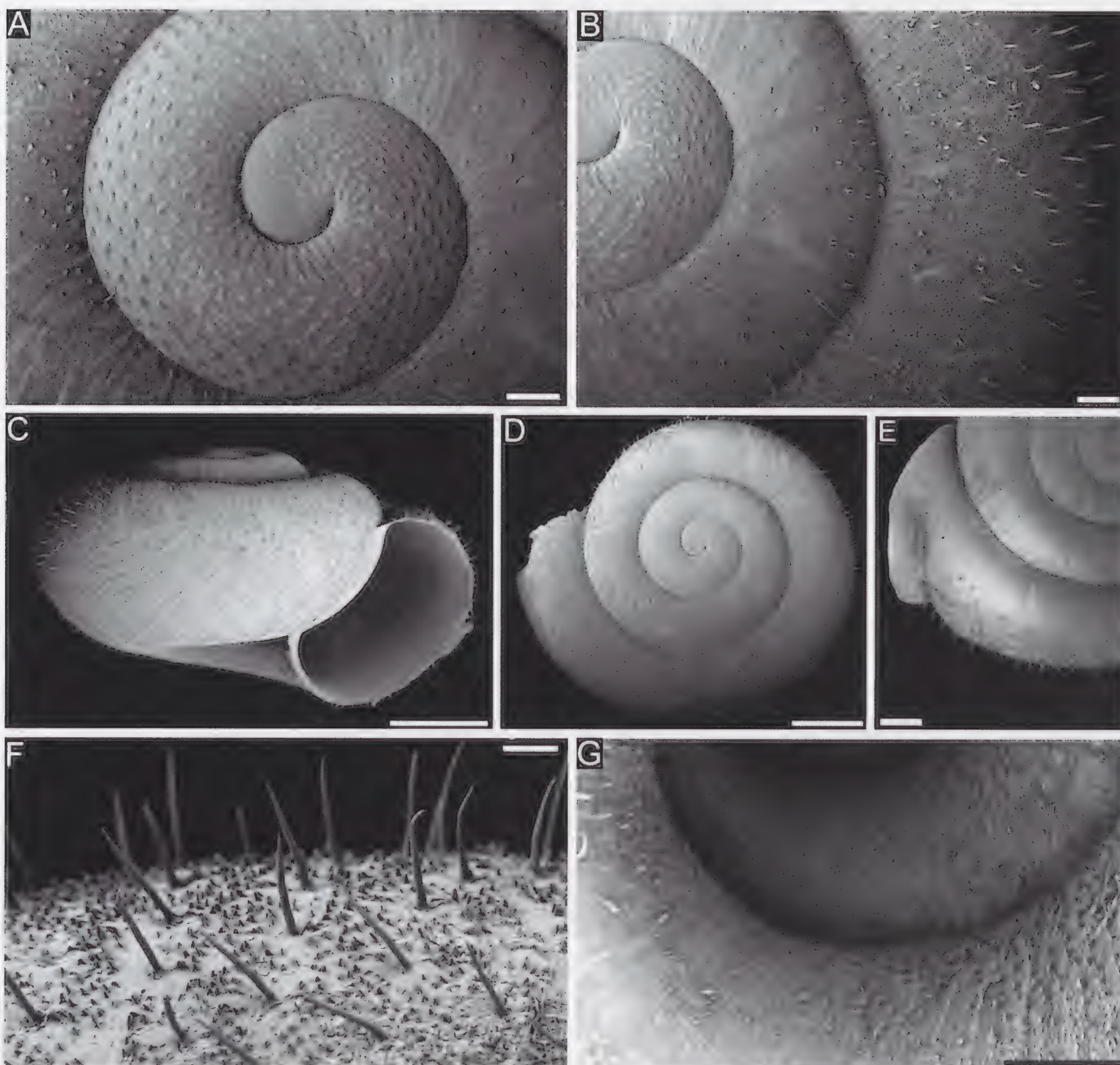


FIG. 129. SEM micrographs of the shell of *Setobaudinia ngurraali* n. sp. paratype AM C471828 (Middle Osborn Island). A: Apical view showing protoconch; B: Sculpture across first three whorls viewed from above. Scale bars A–B = 200 μ m; C: Sub-adult shell with periostracal hairs, lateral view; D: Sub-adult shell, viewed from above; E: Last whorl, kinked behind apertural lip. Scale bars C–E = 1 mm; F: Close-up of last whorl of sub-adult shell showing periostracal hairs and periostracal granules in higher magnification. Scale bar = 100 μ m; G: Close-up of inner umbilicus showing periostracal granules. Scale bar = 200 μ m.

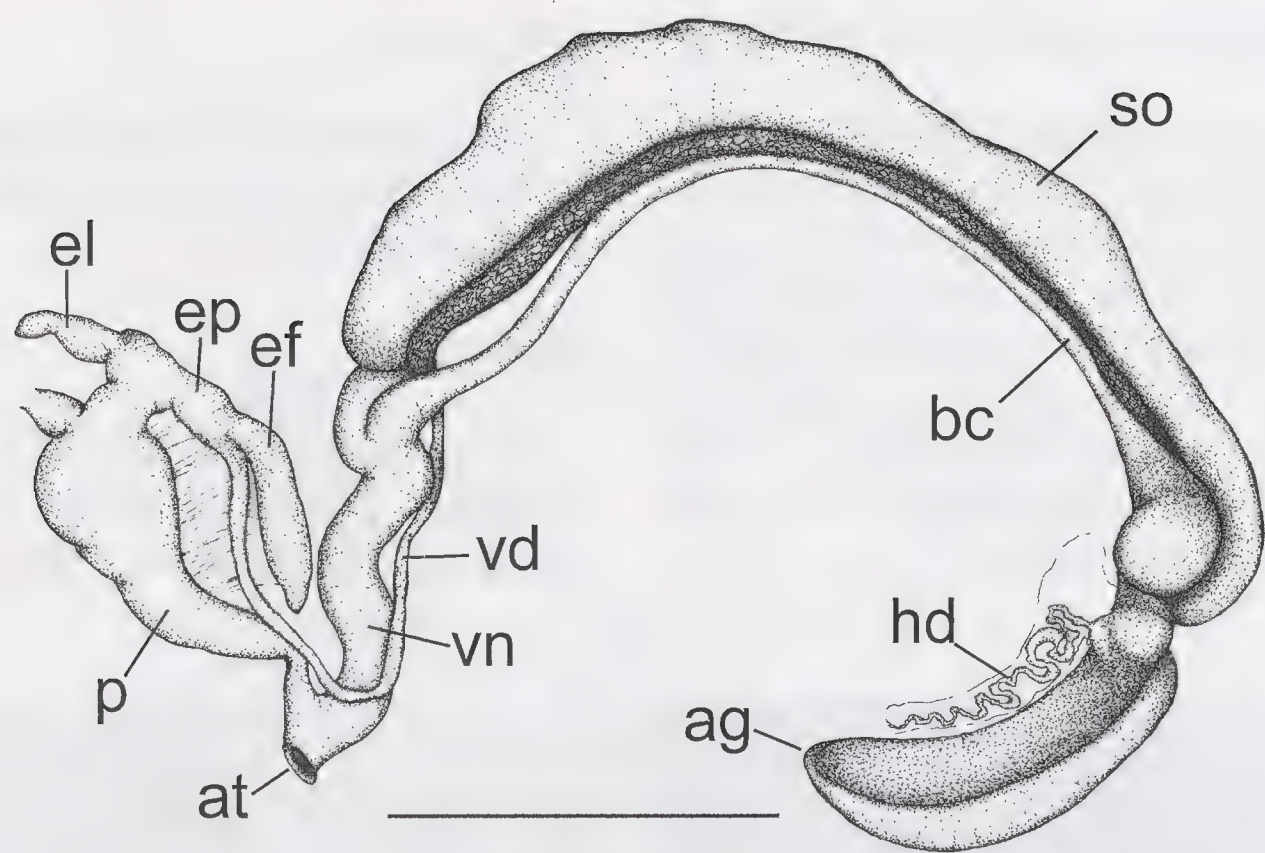


FIG. 130. Genital anatomy of *Setobaudinia ngurraali* n. sp. holotype WAM S49353 (Middle Osborn Island, February). Scale bar = 3 mm.

ery; umbilicus on average 1.9 mm wide; colour yellowish brownish. Protoconch ~ 1.5 mm in diameter, comprising about one whorl, with regular, strong, radially arranged pustulation. Teleoconch with almost invisible, faint radial growth lines extending onto base of shell and into umbilicus, inner umbilical whorls with periostracal granules, shell densely covered with radially arranged periostracal hairs (usually worn off in adults) and microscopic granules. Last whorl shortly descending behind aperture, kinked immediately behind lip; angle of aperture ~ 60°; aperture wide, with sharp, well-expanded, reflected lip, flattened at base with well-developed basal node; palatal portion of lip intended, with weak palatal node, parietal wall delicate.

Genital anatomy (Figs. 130–131): Penis as long as vagina, straight. Epiphallus well developed, same length as penis, with very long epiphallus flagellum and well-developed epiphallus lobe. Interior penial wall completely covered with densely packed, transverse to oblique lamellar pilasters, partitioned by longitudinal gutters, gradually transforming into longitudinal lamellar pilasters towards proximal end of penial wall. Penial retractor muscle short. Vagina longer than free oviduct, tubular to posteriorly expanded.

Mitochondrial Differentiation

Intraspecific genetic distances (6 sequences): 0.0–0.024; interspecific genetic distances: 0.063–0.085 with respect to *S. umbadayi* (5

sequences), 0.147–0.182 to all remaining congeners (24 sequences, 11 species).

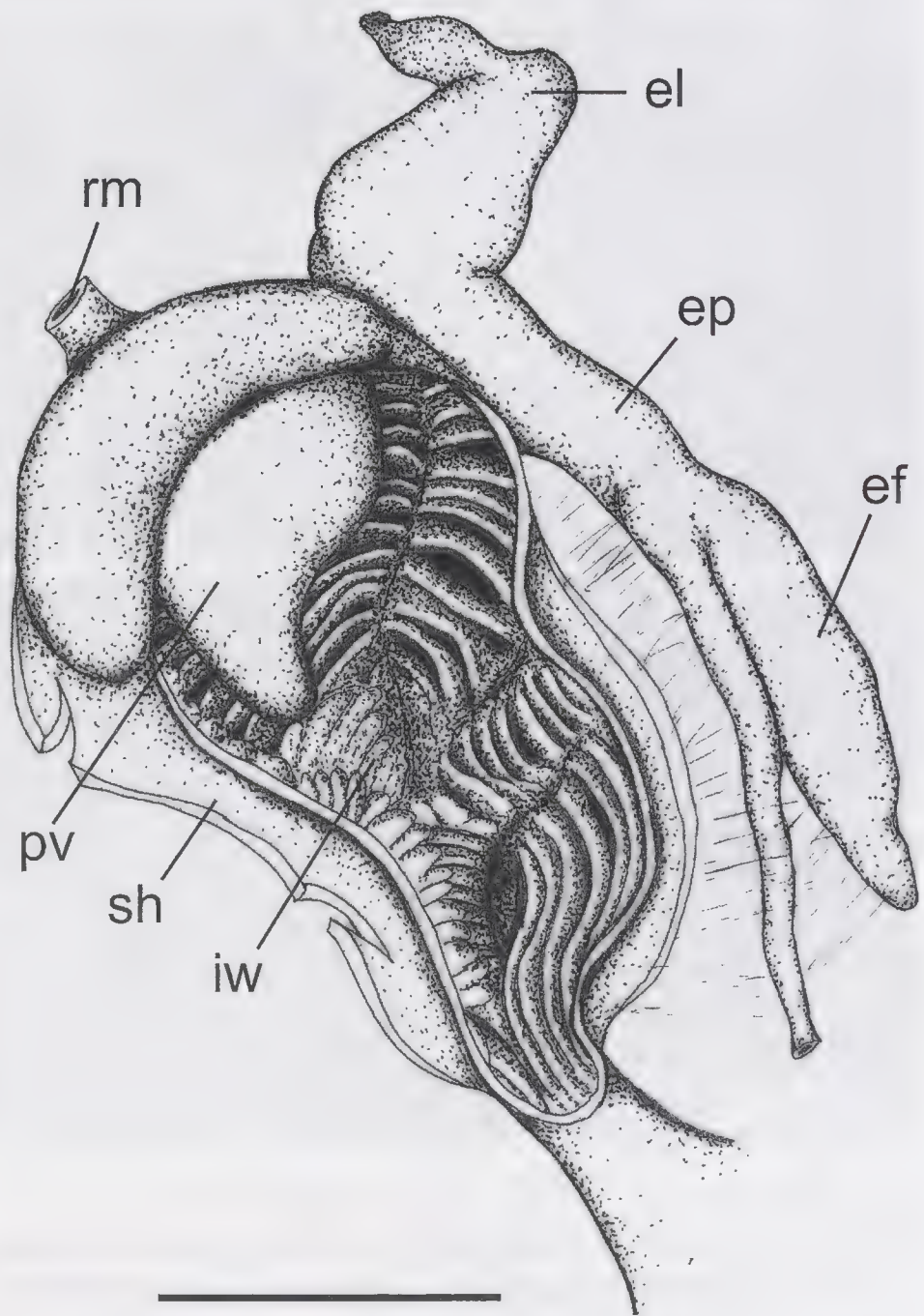


FIG. 131. Penial anatomy of *Setobaudinia ngurraali* n. sp. holotype WAM S58471 (Middle Osborn Island, February). Scale bar = 1 mm.

Comparative Remarks

Shell most similar to *S. hirsuta* Solem, 1985, with regard to features stated to be typical for this species (Solem, 1985a: 755–756), such as presence of pointed periostracal hairs, and indented parietal margin of apertural lip but differing conspicuously in inner penial wall anatomy (with irregularly arranged pilasters in *S. hirsuta*); similarly pilasters shifting from circular to longitudinal arrangement. The second species from mainland localities close to Middle

Osborn Island, *S. calvitia* Solem, 1985, differs most conspicuously by pustulose armature of inner penial wall. *Setobaudinia collingii* has larger shells, lacks densely packed periostracal hairs. See below for comparison with *S. umbadayi*.

Distribution (Fig. 122)

Middle Osborn Island, in western part of island in sympatry with *S. umbadayi*, which appears to be more abundant there.



FIG. 132. SEM micrographs of the shell of *Setobaudinia umbadayi* n. sp. paratype AM C471830 (Southwest Osborn Island). A: Apical view showing protoconch and first whorl; B: Sculpture across entire shell viewed from above. Scale bars A–B = 200 μ m; C: Shell, lateral view; D: Shell viewed from above. Scale bars C–D = 1 mm; E: Close-up of inner umbilicus showing periostracal granules. Scale bar = 200 μ m; F: Close-up of periostracal hair. Scale bar = 100 μ m.

***Setobaudinia umbadayi* n. sp.**
Figs. 123E, 132–134

Type Locality

Western Australia, northwestern Kimberley, Bonaparte Archipelago, Admiralty Gulf, W coast of Southwest Osborn Island, 14°22'29"S, 125°56'19"E; coll. Vince Kessner, 30/07/2007, KIS 3–8 (vine thicket on steep, upper slopes near base of cliffs, volcanic scree and boulders; in leaf litter, under rocks).

Material Examined

Holotype WAM S58474 (preserved specimen, dissected). Paratypes WAM S36708 (19 preserved specimens), AM C471829 (6 preserved specimens), WAM S36709 (8 preserved specimens), WAM S36374 (25 shells), AM C471830 (16 shells), WAM S36379 (23 shells), WAM S36380 (22 shells) from west coast of Southwest Osborn Island.

Additional, non-type material. WAM S36375 – WAM S36378, WAM S36381 – WAM S36384, WAM S36948 – WAM S36950, AM C471831 (shells), WAM S36702 – WAM S36707, WAM S36710 – WAM S36712, WAM S36901, AM C471832 (preserved specimens) from west coast of Southwest Osborn Island; WAM S36719 – WAM S36721 (preserved specimens), WAM S36946 – WAM S36947, WAM

S36372 – WAM S36373, AM C471833 (shells) from west coast of Middle Osborn Island.

Etymology

For Umbadayi, name of Southwest Osborn Island in Gaambera, language of the Unguu people; noun in apposition.

Description

Shell (Figs. 123E, 132): Small ($D = 7.4$ mm on average; Table 9), with low to weakly elevated spire; last whorl slightly angulated above periphery; umbilicus on average 2.1 mm wide; colour yellowish brownish. Protoconch ~ 1.3 mm in diameter, comprising about one whorl, with regular, strong, radially arranged pustulation. Teleoconch with almost invisible, faint radial growth lines extending onto base of shell and into umbilicus, inner umbilical whorls with periostracal granules, shell densely covered with radially arranged periostracal hairs (usually worn in adults) and microscopic granules. Last whorl shortly descending behind aperture, kinked immediately behind lip; angle of aperture ~ 60°; aperture wide, with sharp, strongly expanded and reflected lip, flattened at base with strongly developed basal node; palatal portion of lip intended, with weak palatal node, parietal wall delicate.

Genital anatomy (Figs. 133–134): Penis as long as vagina, straight. Epiphallus well devel-

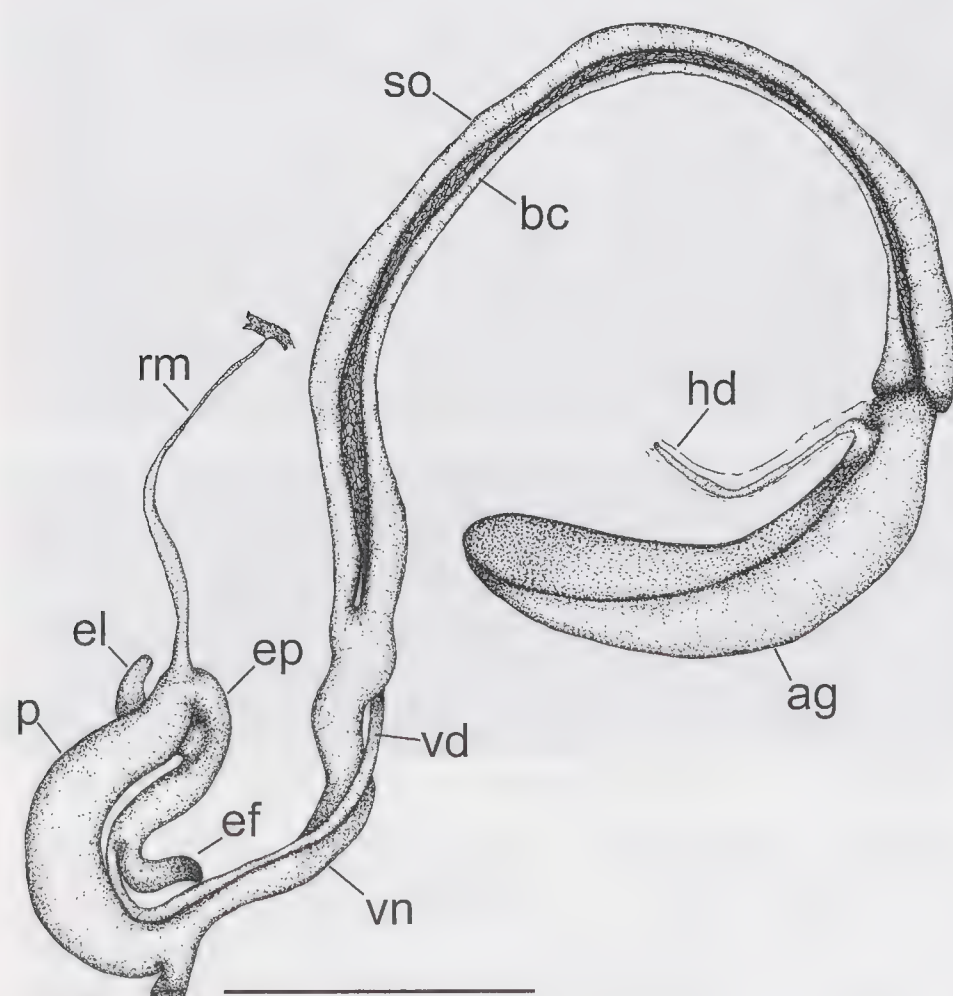


FIG. 133. Genital anatomy of *Setobaudinia umbadayi* n. sp. holotype WAM S58474 (Southwest Osborn Island, July). Scale bar = 2 mm.

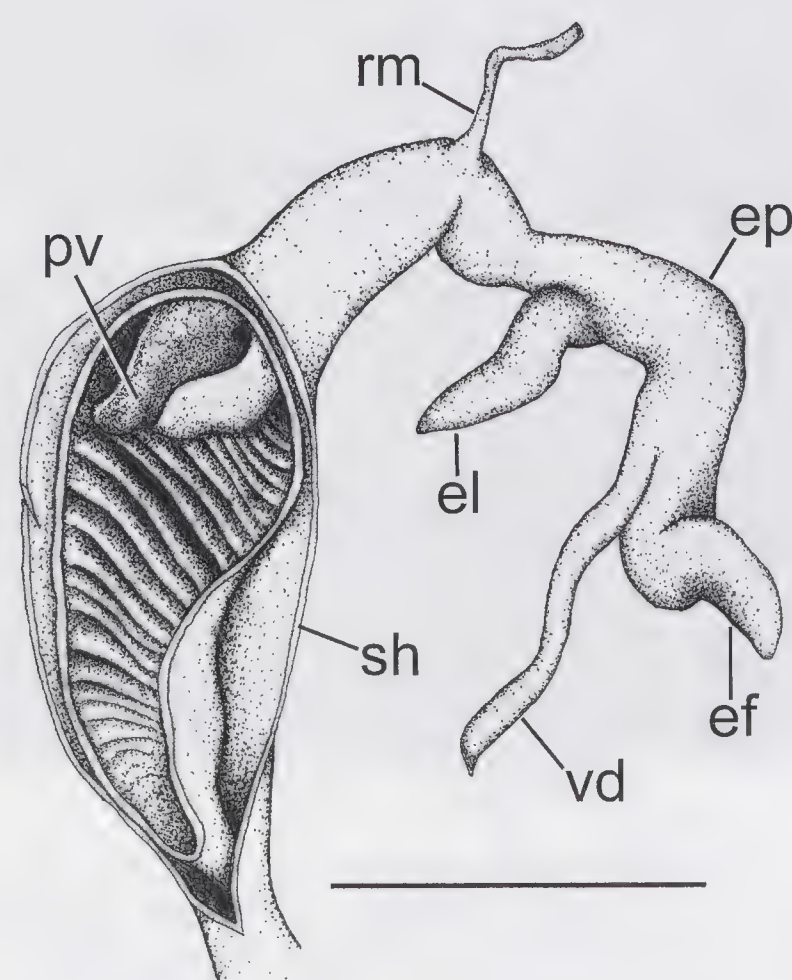


FIG. 134. Penial anatomy of *Setobaudinia umbadayi* n. sp. holotype WAM S58474 (Southwest Osborn Island, July). Scale bar = 1 mm.

oped, more or less as long as penis, with very long epiphallic flagellum and well-developed epiphallic lobe. Interior penial wall completely covered with densely packed, transverse to slightly oblique lamellar pilasters, their elevation tapering towards proximal end of penial wall. Penial retractor muscle short. Vagina longer than free oviduct, tubular to posteriorly expanded.

Mitochondrial Differentiation

Intraspecific genetic distances (5 sequences): 0.0–0.049; interspecific genetic distances: 0.063–0.085 with respect to *S. ngurraali* (6 sequences), 0.154–0.172 to all remaining congeners (24 sequences, 11 species).

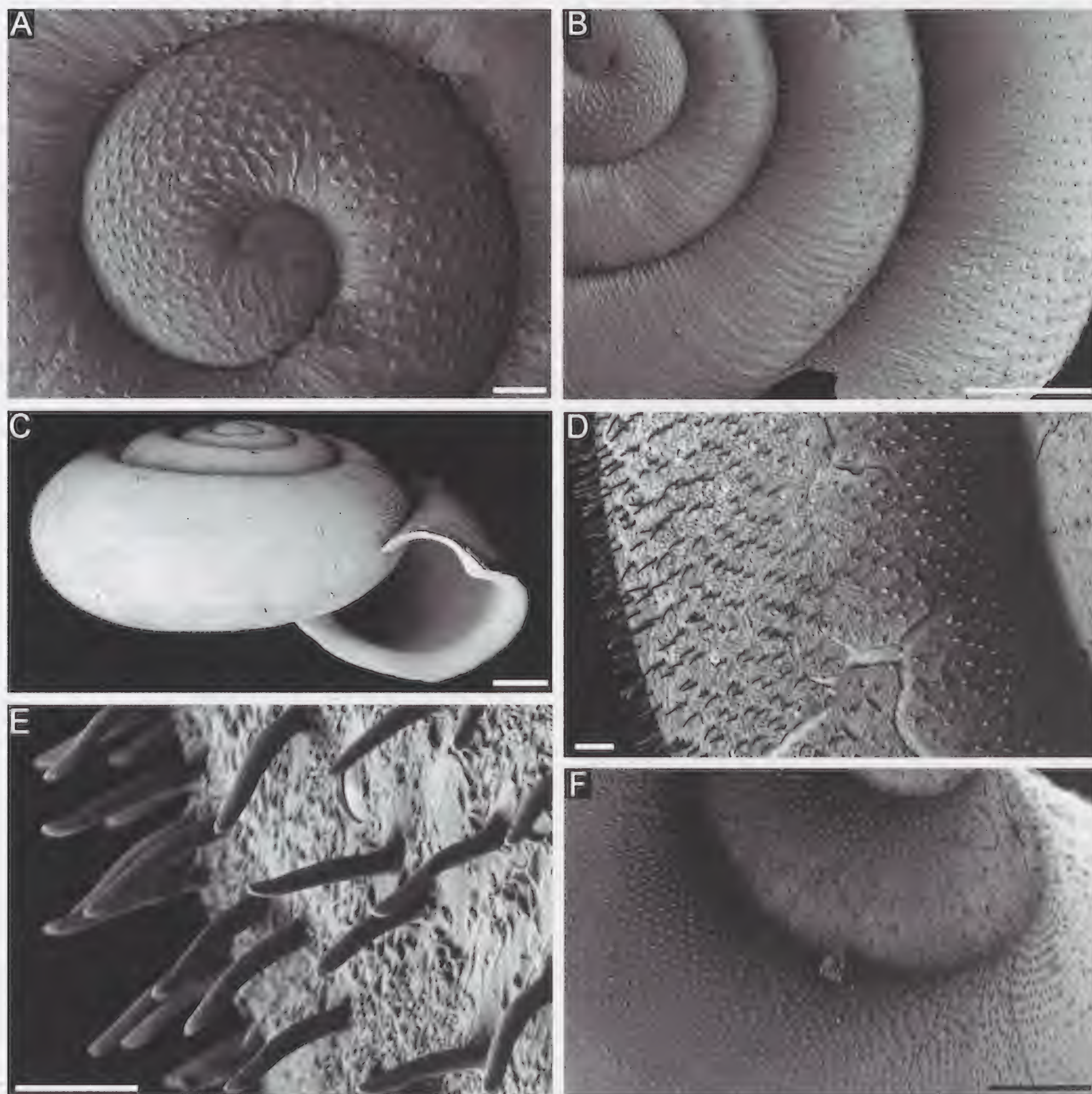


FIG. 135. SEM micrographs of the shell of *Setobaudinia wuyurru* n. sp. (Bigge Island). A–B: Paratype AM C471834. A: Apical view showing protoconch. Scale bar = 200 μ m; B: Sculpture across entire shell viewed from above. Scale bar = 1 mm; C–F: Paratype WAM S36749. C: Shell, frontal view showing aperture. Scale bar = 1 mm; D: Last whorl viewed from obliquely from above showing periostracal hairs. Scale bar = 200 μ m; E: Close-up showing periostracal hairs on last whorl. Scale bar = 100 μ m; F: Close-up inner umbilical whorls showing periostracal granules. Scale bar = 500 μ m.

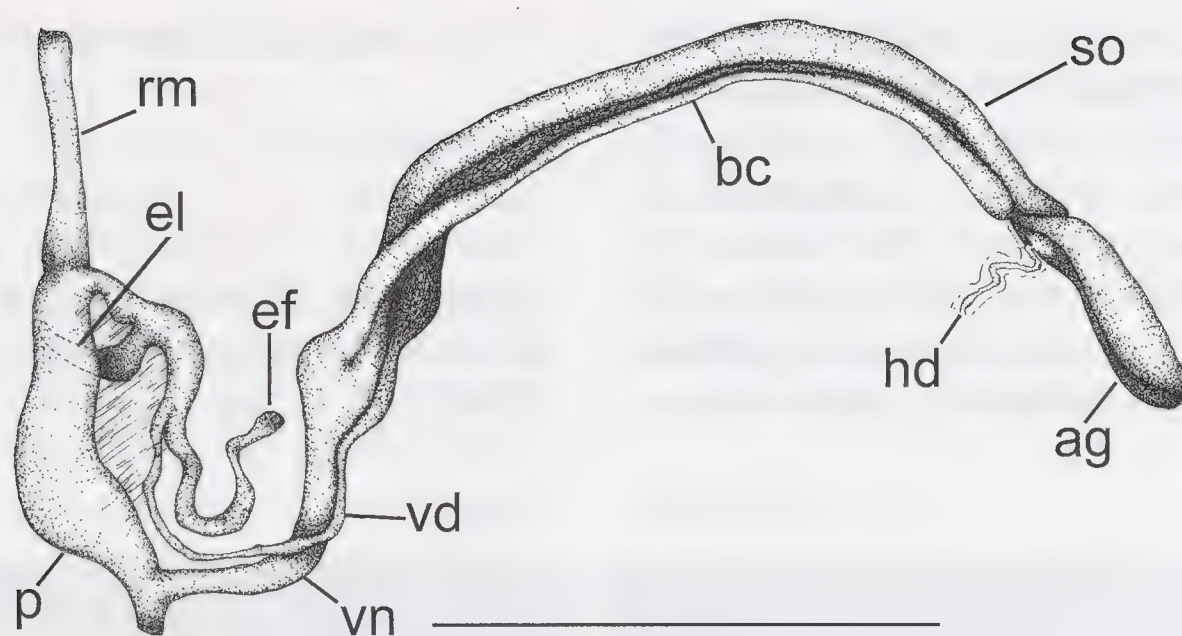


FIG. 136. Genital anatomy of *Setobaudinia wuyurru* n. sp. holotype WAM S58475 (Bigge Island, August). Note that the epiphallic lobe (el) is partly concealed. Scale bar = 3 mm.

Comparative Remarks

Most similar to its putative sister species *S. ngurraali* from Middle Osborn Island. The lot WAM 36719 from western coast of Middle Osborn Island was found to contain both specimens of *S. ngurraali* and *S. umbadayi*, proving that both species occur in sympatry in parts of their ranges. Apertural lip more strongly expanded and reflected in *S. umbadayi*; most conspicuous difference is simpler armature of inner penial wall and lack of longitudinal pilasters or gutters. For comparison with *S. hirsuta*, *S. calvitia* and *S. collingii* compare with *S. ngurraali*.

Distribution (Fig. 122)

Southwest Osborn Island and western portion of Middle Osborn Island (here in sympatry with *S. ngurraali*); occurrence on Kidney Island in between both islands likely.

Setobaudinia wuyurru n. sp.

Figs. 123F, 135–137

Type Locality

Western Australia, northwestern Kimberley, Bonaparte Archipelago, west coast of Bigge Island, 9.17 km NW of Savage Hill, 14°35'12"S, 125°06'13"E; coll. Michael Shea, 3/08/2007, KIS 1–18 (rocky ridge top with caves and vine thicket; in leaf litter between rocks).

Material Examined

Holotype WAM S58475 (preserved specimen). Paratypes WAM S36749 (2 preserved specimens), WAM S36974 (preserved speci-

men), WAM S36351 (3 shells), WAM S36352 (4 shells, Fig. 123F), AM C471834 (shell), WAM S58476 (3 preserved specimens), WAM S36353 (4 shells), WAM S36354 (shell), WAM S36355 (6 shells), AM C471835 (2 shells), WAM S36356 (8 shells), WAM S36748 (shell) from west coast of Bigge Island.

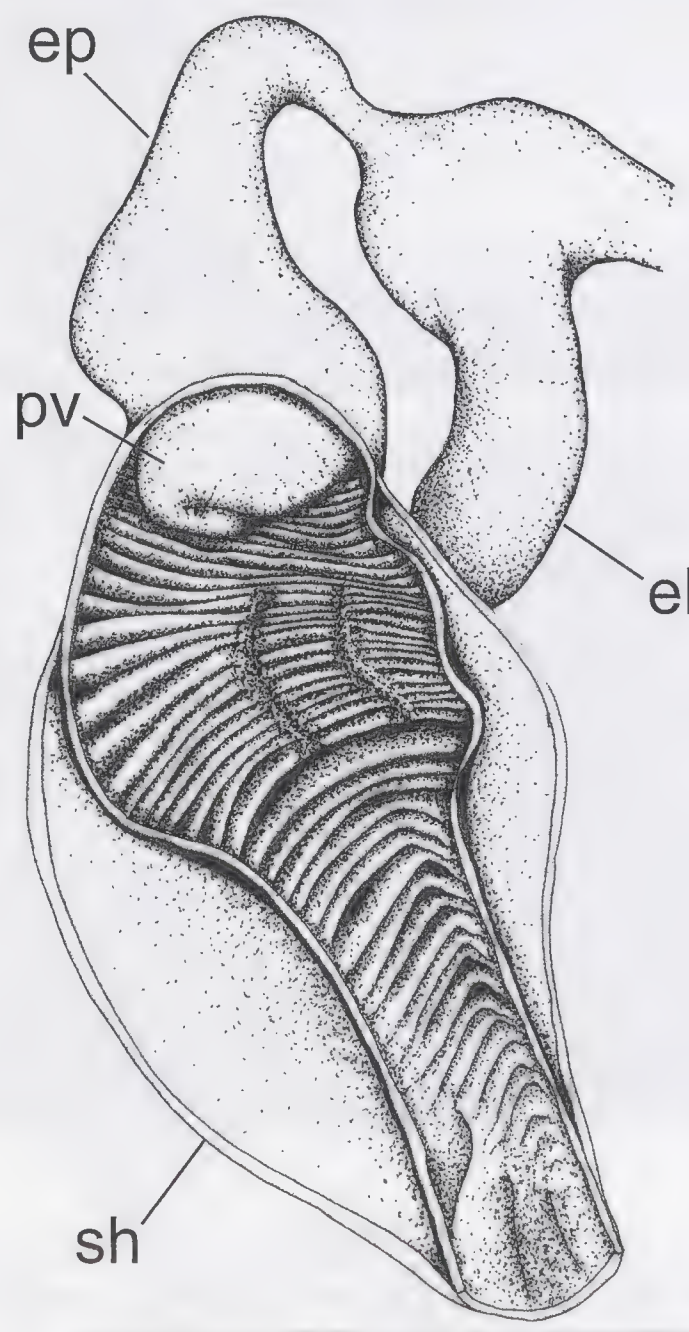


FIG. 137. Penial anatomy of *Setobaudinia wuyurru* n. sp. holotype WAM S58475 (Bigge Island, August). Scale bar = 1 mm.

Etymology

For Wuyurru, name of Bigge Island in Wunambal, language of the Unguu people; noun in apposition.

Description

Shell (Figs. 123F, 135): Small ($D = 8.5$ mm on average; Table 9), with low to weakly elevated spire; periphery well rounded; umbilicus on average 2.5 mm wide; colour light yellowish brownish. Protoconch ~ 1.1 mm in diameter, comprising about one whorl, with regular, strong, radially arranged pustulation. Teleoconch with almost invisible, faint radial growth lines extending onto base of shell and into umbilicus, inner umbilical whorls with periostracal granules, shell densely covered with radially arranged, short periostracal hairs (usually worn off in adults) and microscopic granules, which are pronounced underneath suture. Last whorl weakly descending behind aperture, slightly kinked immediately behind lip; angle of aperture $\sim 60^\circ$; aperture wide, with sharp, weakly expanded and reflected lip, slightly flattened at base, basal node weak or absent; palatal portion of lip slightly intended, parietal wall delicate.

Genital anatomy (Figs. 136–137): Penis as long as vagina, straight. Epiphallus as long as penis, attached to penis by connective tissue, with very long epiphallic flagellum and well-developed epiphallic lobe. Interior penial wall completely covered with densely packed, transverse to slightly oblique lamellar pilasters, their elevation tapering towards proximal end of penial wall, in mid-portion divided by longitudinal gutters on posterior portion of wall. Penial retractor muscle short. Vagina longer than free oviduct, tubular to posteriorly expanded.

Mitochondrial Differentiation

Intraspecific genetic distances (2 sequences): 0.007; interspecific genetic distances: 0.154–0.182 to all remaining congeners (33 sequences, 12 species).

Comparative Remarks

Shell slightly larger than *S. ngurraali* and *S. umbadayi*, with weaker indentation, expansion and reflection of lip, shorter periostracal hairs. Inner penial wall most similar to *S. ngurraali*, which lacks longitudinal gutters. Species genetically well differentiated.

Distribution (Fig. 122)

Bigge Island.

Setobaudinia capillacea n. sp.

Figs. 123G, 138–140

Type Locality

Western Australia, northwestern Kimberley, Bonaparte Archipelago, central section of Boongaree Island, $15^\circ 04' 22''$ S, $125^\circ 10' 56''$ E; coll. Michael Shea, 7/08/2007, KIS 1–27 (dry open eucalypt woodland or grassland with baobab on dolerite; in soil under litter).

Material Examined

Holotype WAM S58477 (preserved specimen). Paratypes WAM S36752 (3 preserved specimens), WAM S36357 (14 shells), WAM S36358 (10 shells), AM C471836 (9 shells), WAM S36359 (30 shells), AM C471837 (10 shells), WAM S36360 (10 shells), WAM S36361 (6 shells), WAM S36362 (shell), WAM S36363 (2 shells), WAM S36364 (14 shells), WAM S36365 (4 shells), WAM S36750 (preserved specimen), WAM S36751 (4 preserved specimens), WAM S36753 (5 preserved specimens), AM C471838 (3 preserved specimens), WAM S36754 (2 preserved specimens), WAM S37688 (8 preserved specimens), WAM S36755 (7 preserved specimens) from central section of Boongaree Island.

Etymology

Derived from “*capillaceus*” (Latin, masculine = hairy), referring to dense coverage of shell with short periostracal hairs; adjective of feminine gender.

Description

Shell (Figs. 123G, 138): Small ($D = 8.8$ mm on average; Table 9), with weakly to moderately elevated spire; periphery well rounded; umbilicus on average 2.5 mm wide; colour light yellowish brownish. Protoconch ~ 1.2 mm in diameter, comprising about one whorl, with regular, strong, radially arranged pustulation. Teleoconch with almost invisible, faint radial growth lines extending onto base of shell and into umbilicus, inner umbilical whorls with periostracal granules, shell densely covered with triangularly shaped periostracal extensions

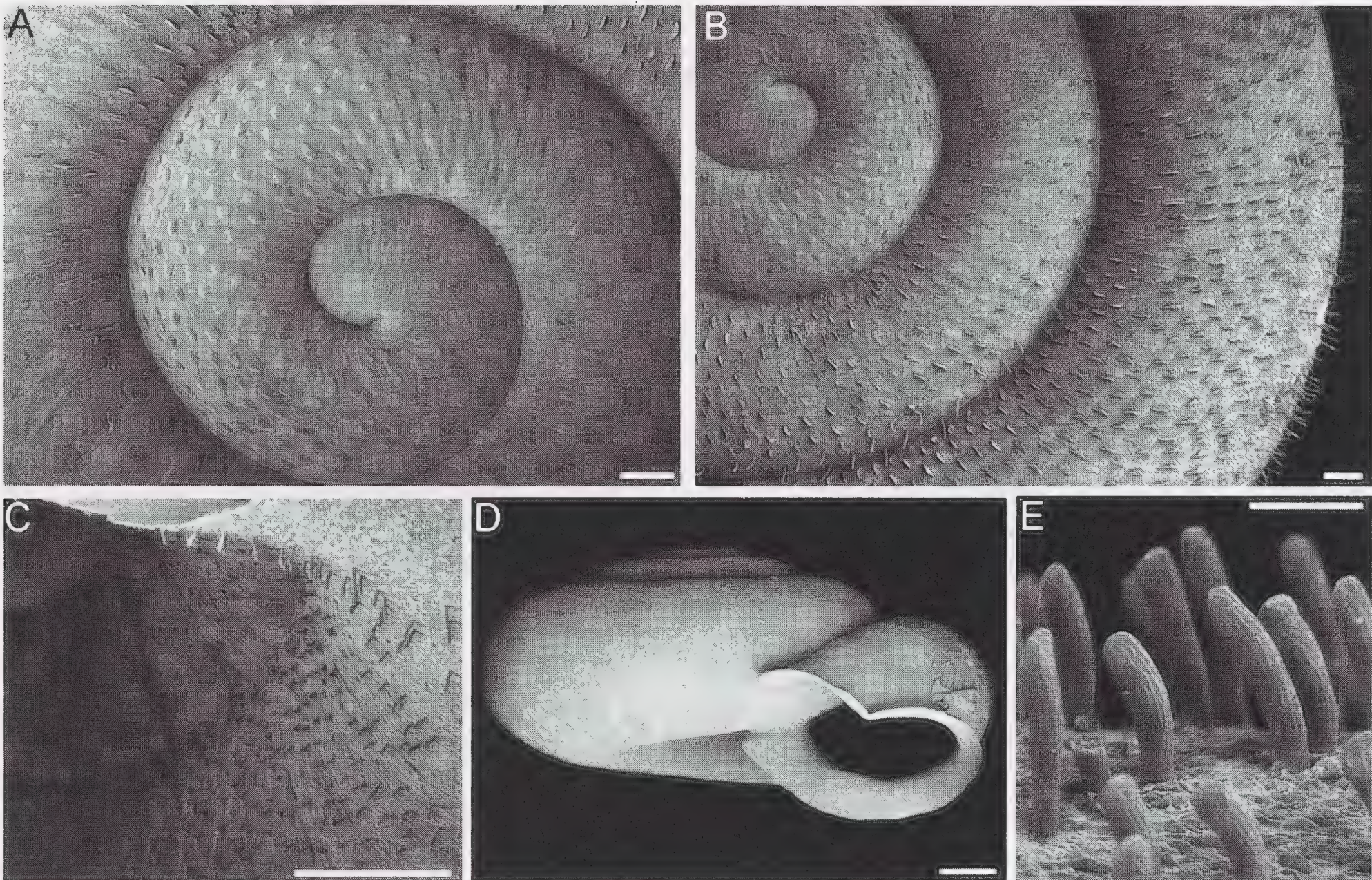


FIG. 138. SEM micrographs of the shell of *Setobaudinia capillacea* n. sp. paratype AM C471836 (Boongaree Island). A: Apical view showing protoconch; B: Sculpture across entire shell viewed from above. Scale bars A–B = 200 µm; C: Close-up inner umbilical whorls showing periostracal granules. Scale bar = 500 µm; D: Shell, frontal view showing aperture. Scale = 1 mm; E: Close-up showing periostracal hairs on mid-portion of last whorl. Scale bar = 50 µm.

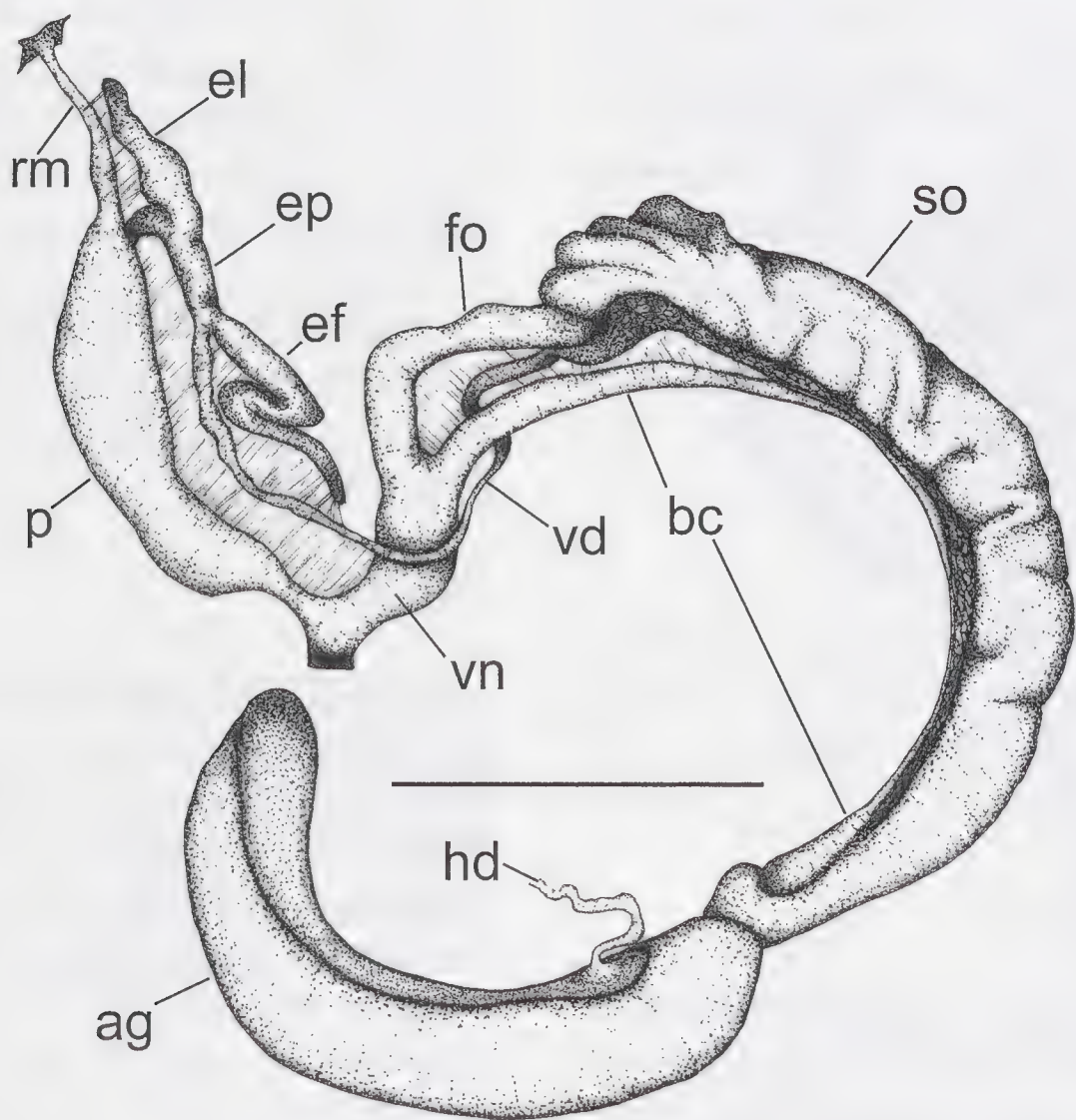


FIG. 139. Genital anatomy of *Setobaudinia capillacea* n. sp. holotype WAM 58477 (Boongaree Island, August). Scale bar = 3 mm.

that are arranged in parallel radial rows with their broadest side facing direction of coiling (Fig. 138B). These extensions are replaced by short, blunt, thick periostracal hairs on last whorl from periphery downward into umbilicus. Sculpture also comprises microscopic granules on entire shell being more pronounced underneath suture. Extensions, hairs and granules may be worn in adults. Last whorl weakly descending behind aperture, slightly kinked immediately behind lip; angle of aperture $\sim 60^\circ$; aperture wide, with sharp, weakly expanded and reflected lip, slightly flattened at base, basal node weak or absent; palatal portion of lip slightly intended, parietal wall delicate.

Genital anatomy (Figs. 139–140): Penis longer than vagina, straight. Epiphallus as long as penis, with very long epiphallic flagellum and long epiphallic lobe. Interior penial wall completely covered with densely packed, transverse lamellar pilasters, proximally being replaced by laterally elongated pustules. Penial verge large. Penial retractor muscle short. Vagina about same length as free oviduct, tubular to posteriorly expanded.

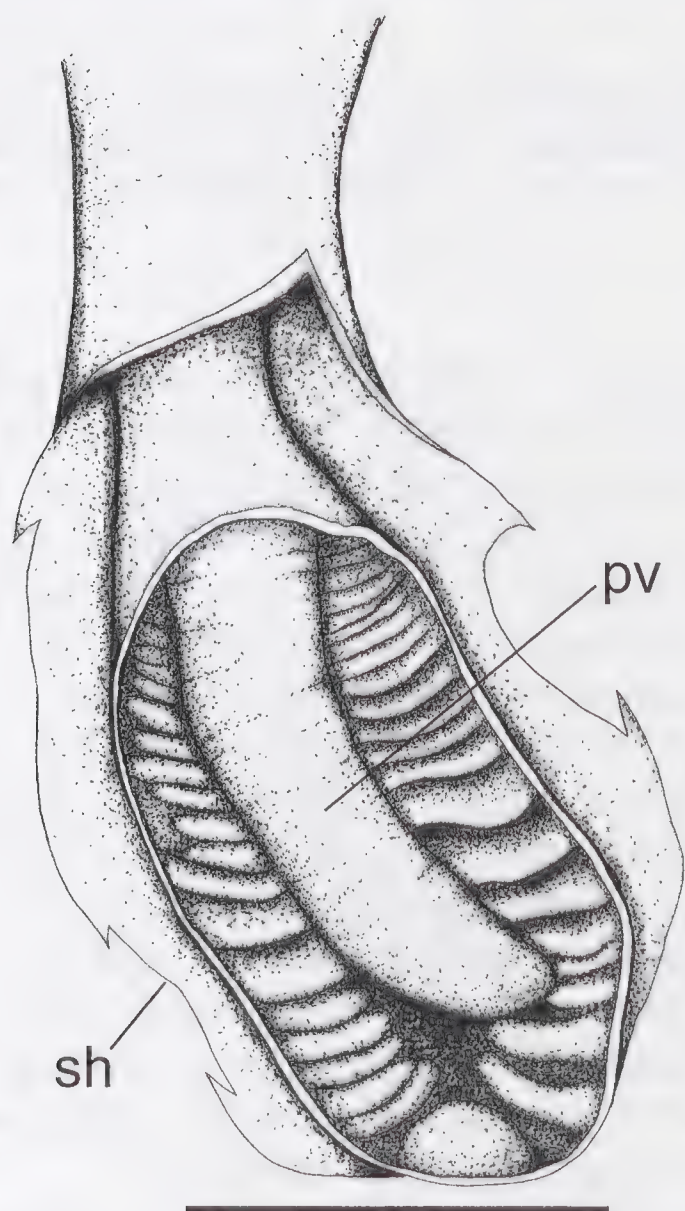


FIG. 140. Penial anatomy of *Setobaudinia capillacea* n. sp. holotype WAM 58477 (Boongaree Island, August). Scale bar = 1 mm.

Mitochondrial Differentiation

Intraspecific genetic distances (2 sequences): 0.007; interspecific genetic distances: 0.154–0.182 to all remaining congeners (33 sequences, 12 species).

Comparative Remarks

Shell slightly larger and proportionally higher than *S. ngurraali*, *S. umbadayi*, and *S. wuyuru*. Microsculpture of triangular periostracal extensions and short, blunt, thick periostracal hairs on base of shell typical.

Distribution (Fig. 122)

Boongaree Island.

***Setobaudinia garlinju* n. sp.**
Figs. 123H, 141–144

Type Locality

Western Australia, central Kimberley coast, Bonaparte Archipelago, N section of Coronation Island, $14^\circ 58' 30''$ S, $124^\circ 54' 31''$ E; coll. Vince Kessner, 27/05/2008, KIS 3–72 (vine thicket on steep lower slopes with skeletal soil; large volcanic rocks; under rocks in loose soil).

Material Examined

Holotype WAM S58478 (preserved specimen, dissected). Paratypes WAM S37045 (7 preserved specimens), AM C471839 (18 shells), AM C471840 (20 shells), WAM S37366 (20 shells), WAM S37047 (11 preserved specimens), WAM S37368 (32 shells) from northern section of Coronation Island.

Additional, non-type material. WAM S37039 – WAM S37044, WAM S37046, WAM S37048 (preserved specimens), AM C471841, WAM S37359 – WAM S37365, WAM S37367, WAM S37369 (shells) from northern section of Coronation Island; AM C471842, WAM S37049 – WAM S37055 (preserved specimens), AM C471843, WAM S37370 – WAM S37379 (shells) from southern section of Coronation Island.

Etymology

For Garlinju, name of Coronation Island in Wunambal, language of the Uunguu people; noun in apposition.

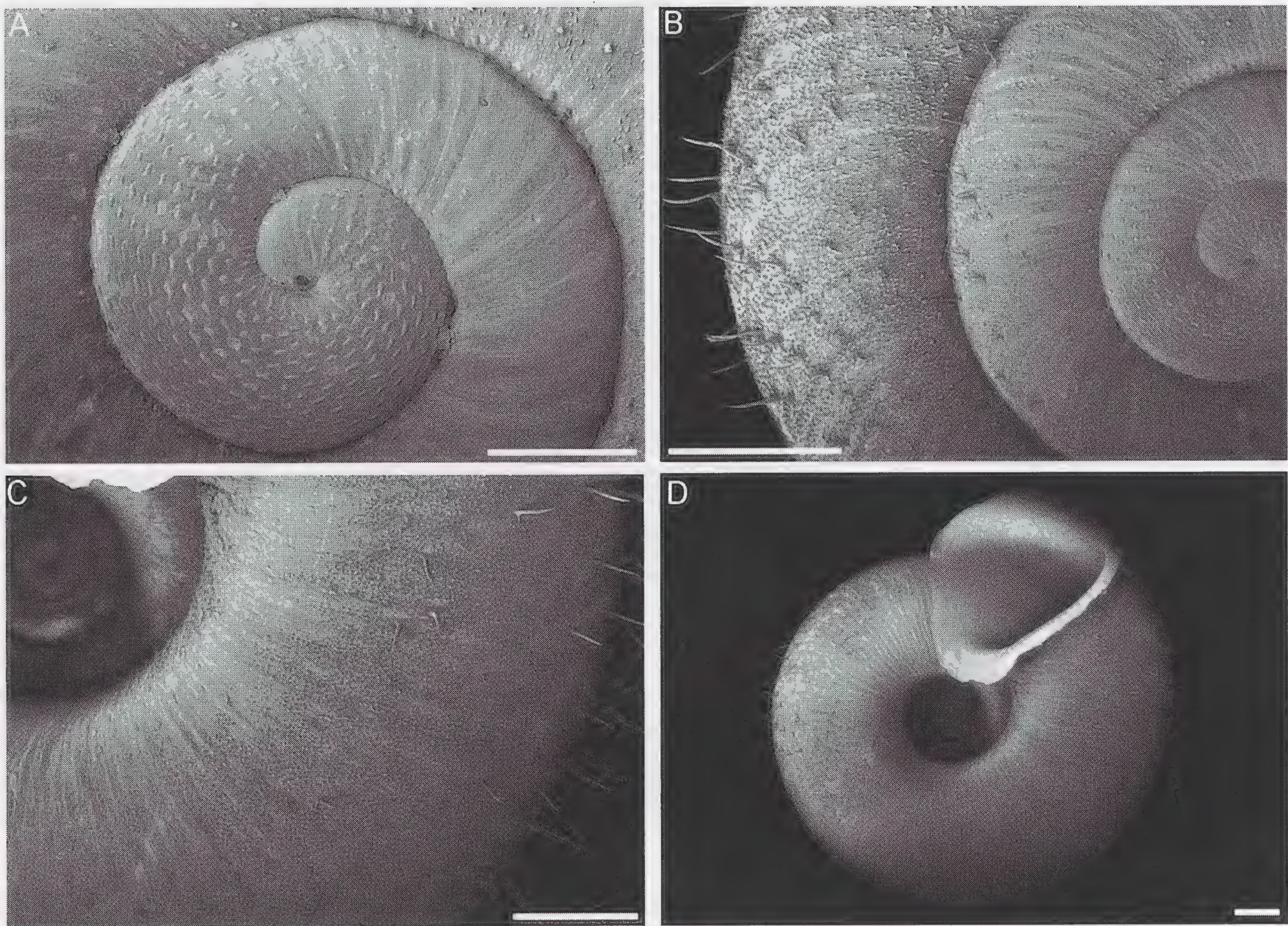


FIG. 141. SEM micrographs of the shell of *Setobaudinia garlinju* n. sp. paratype AM C471840 (Coronation Island). A: Apical view showing protoconch. Scale bar = 500 μm; B: Sculpture across entire shell viewed from above; C: Umbilical view; D: Shell from below showing aperture. Scale bars B–D = 1 mm.

Description

Shell (Figs. 123H, 141). Small (D = 8.3 mm on average; Table 9), with weakly to moderately elevated spire; periphery angulated; umbilicus

on average 1.9 mm wide; colour light yellowish brownish. Protoconch ~ 1.4 mm in diameter, comprising about one whorl, with regular, strong, radially arranged pustulation. Teleoconch with almost invisible, faint radial growth lines extending onto base of shell and into umbilicus, inner umbilical whorls with periostracal granules, shell sparsely covered with radially arranged, pointed periostracal hairs (usually worn off in adults), and microscopic wavy axial ridglets. Last whorl weakly to moderately descending behind aperture; angle of aperture 45–60°; aperture wide, with sharp, well- to strongly expanded, weakly reflected lip, flattened at base, basal node weak or absent; palatal margin well rounded without indentation, parietal wall delicate.

Genital anatomy and head wart (Figs. 142–144). Penis as long as vagina, slightly twisted into S-shape. Epiphallus almost as long as penis, with moderately long epiphallic flagellum and well-developed epiphallic lobe. Distal half of inner penial wall smooth; proximal half completely covered with densely packed, later-

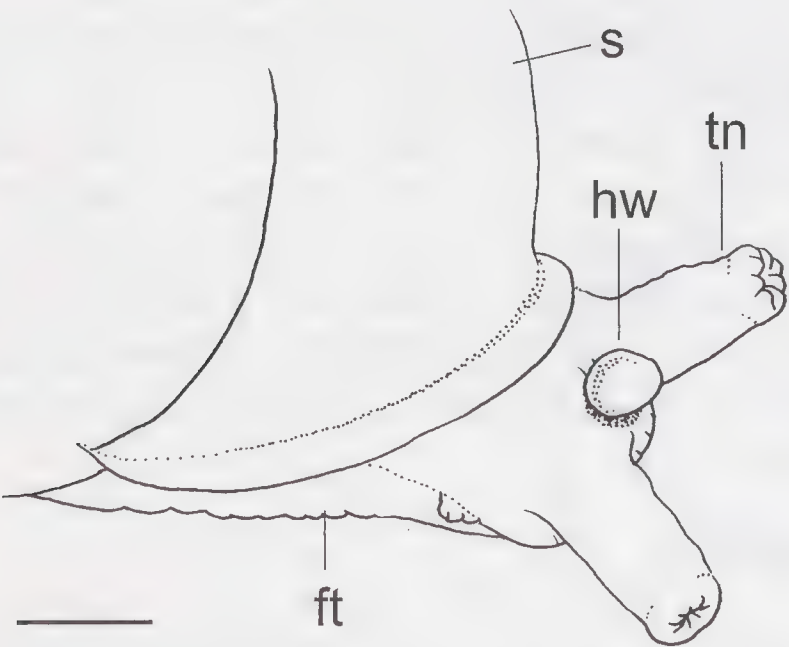


FIG. 142. Head of *Setobaudinia garlinju* n. sp. holotype WAM S58478 with ever-sed head wart. Scale bar = 1 mm.

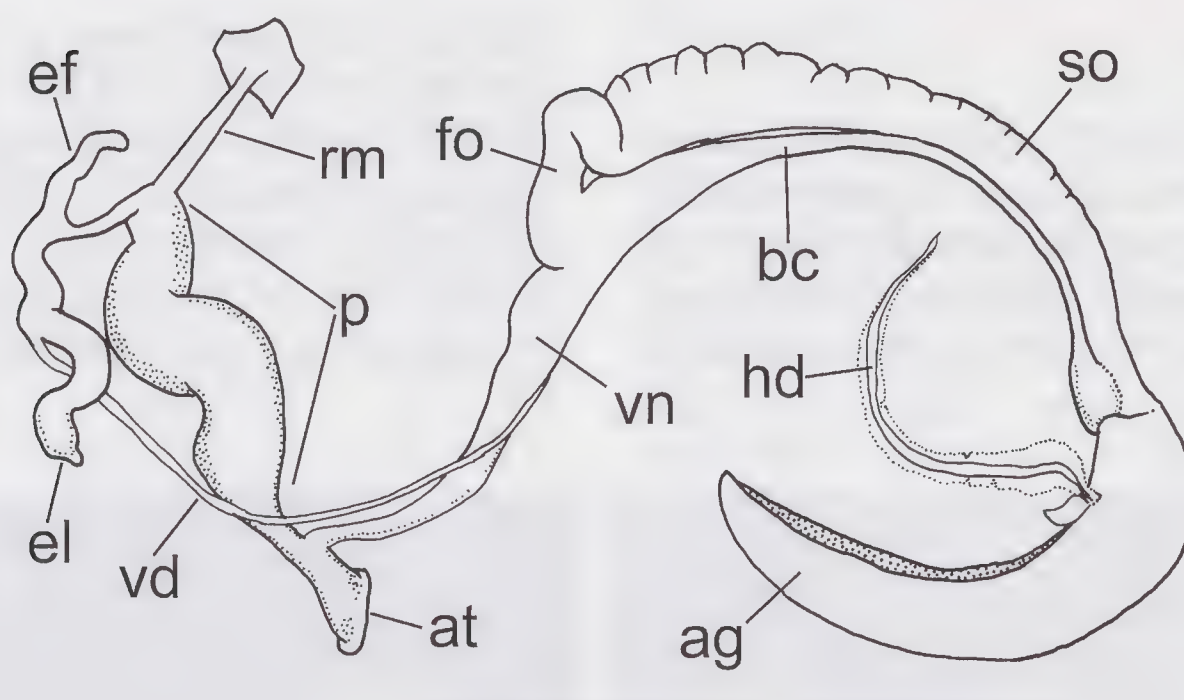


FIG. 143. Genital anatomy of *Setobaudinia garlinju* n. sp. holotype WAM S58478 (Coronation Island, May). Scale bar = 5 mm.

ally strongly elongated pustules, distally being replaced by more rounded, smaller pustules. Penial verge extends about half of length of penial chamber, elongate, thick, with blunt end. Penial retractor muscle comparatively long. Vagina tubular, elongate much longer than free oviduct. Head wart round and smooth (Fig. 142).

Mitochondrial Differentiation

Intraspecific genetic distances (3 sequences): 0.001–0.01; interspecific genetic distances: 0.13 with respect to *S. insolita* (1 sequence), 0.123–0.124 to *S. gumalamala* (2 sequences), and 0.158–0.186 to all remaining congeners (29 sequences, 10 species).

Comparative Remarks

One of the smaller species; in contrast to *S. hirsuta*, *S. ngurraali*, *S. umbadayi* and *S. wuyurana*, last whorl not conspicuously kinked behind aperture. These species also differ in presence of lateral pilasters at inner penial wall rather than laterally elongated pustules. Penial verge of *S. garlinju* exceptionally long, microsculpture of shell comparatively inconspicuous with few but long periostracal hairs, pustulation of inner umbilicus comparatively sparse.

Distribution (Fig. 122)

Coronation Island.

***Setobaudinia gumalamala* n. sp.**
Figs. 123I, 145–147

Type Locality

Western Australia, central Kimberley coast, Saint George Basin, St Andrew Island, 15°21'34"S, 124°59'45"E; coll. Roy Teale, 25/05/2008, KIS-042 (sandstone scree on lower slopes under dense woodland; under rocks in loose soil).

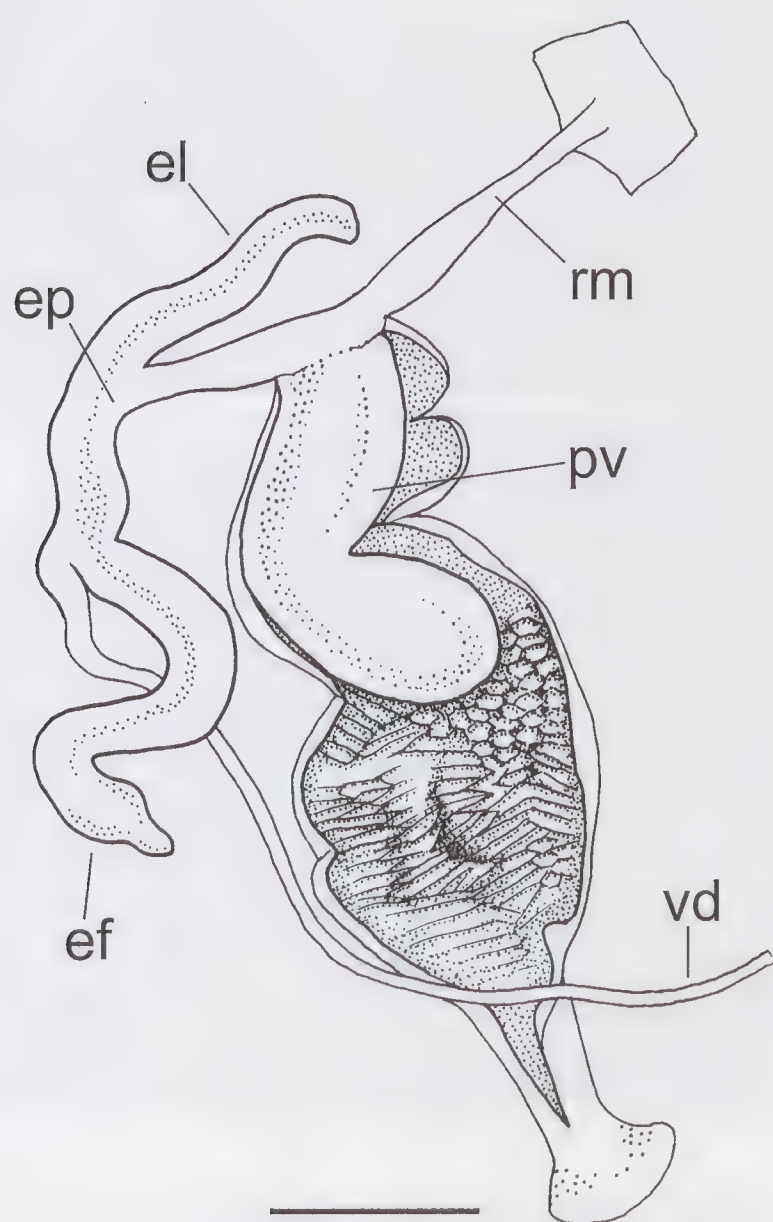


FIG. 144. Penial anatomy of *Setobaudinia garlinju* n. sp. holotype WAM S58478 (Coronation Island, May). Scale bar = 1 mm.

Material Examined

Holotype WAM S58479 (preserved specimen, dissected). Paratypes WAM S37032 (2 preserved specimens), WAM S37271 (9 shells) from type locality; WAM S37268 (shell) from 15°21'26"S, 124°59'48"E; WAM S37031

(preserved specimen), WAM S37269 (3 shells) from 15°21'34"S, 125°00'07"E; WAM S37087 (preserved specimen), WAM S37270 (4 shells) from 15°21'34"S, 125°59'59"E; WAM S37272 (4 shells), AM C471844 (2 shells) from 15°21'24"S, 124°59'46"E; WAM S37034 (3 preserved specimens) from 15°21'32"S,

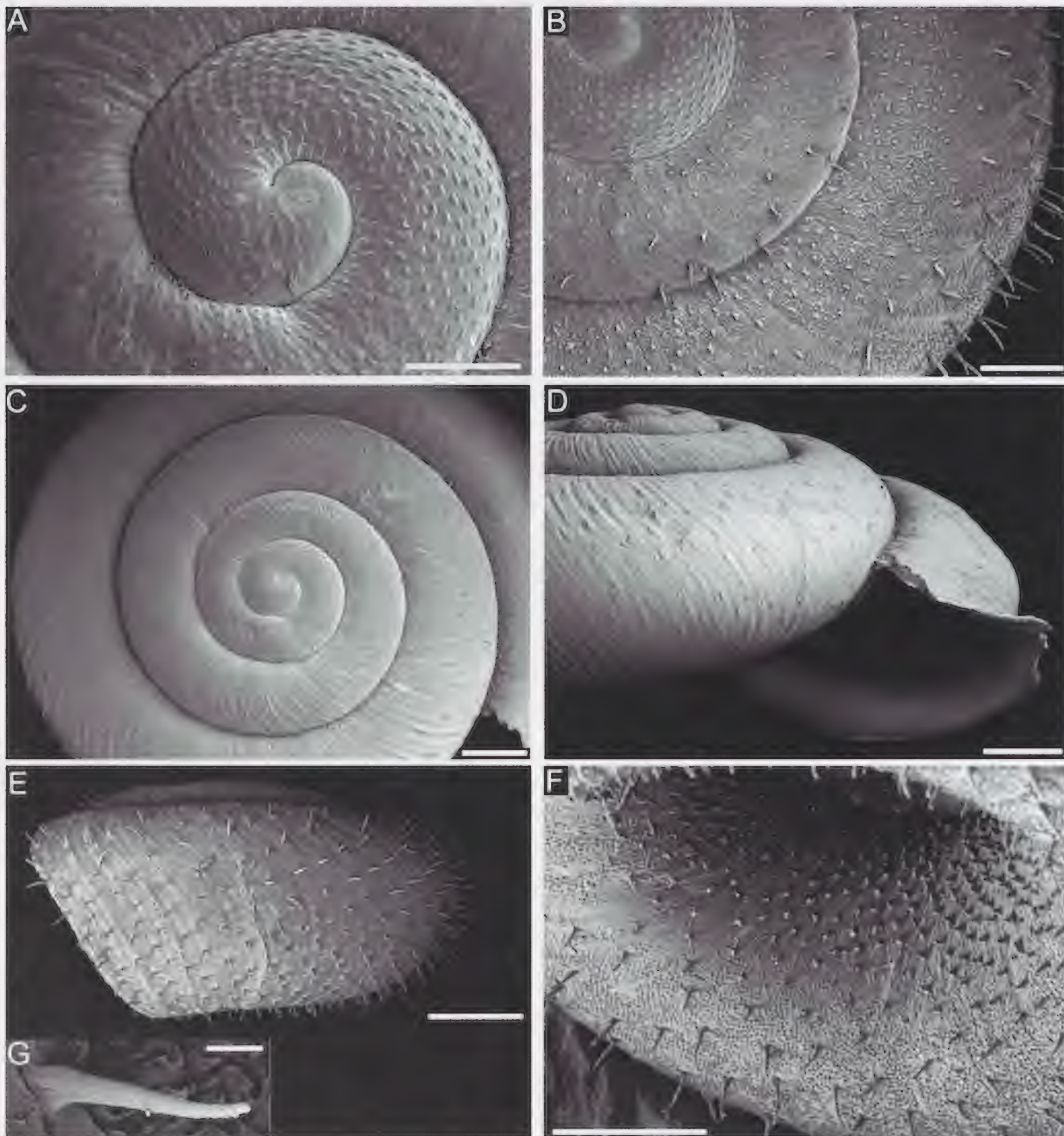


FIG. 145. SEM micrographs of the shell of *Setobaudinia gumalamala* n. sp. paratype AM C471844 (St Andrews Island). A: Apical view showing protoconch; B: Sculpture across entire shell viewed from above. Scale bars A–B = 500 µm; C: Entire shell viewed from above; D: Frontal view showing sculpture on last whorl and aperture; E: Sub-adult shell with periostracal hairs. Scale bars C–E = 1 mm; F: Umbilical view showing periostracal hairs and granules. Scale bar = 500 µm; G: Close-up of periostracal hair. Scale bar = 100 µm.

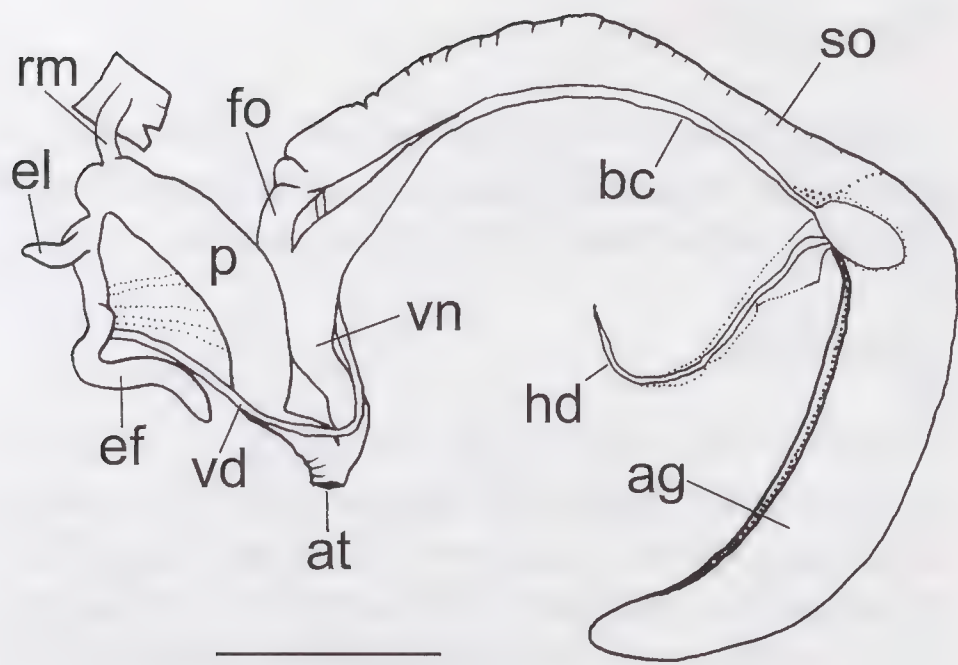


FIG. 146. Genital anatomy of *Setobaudinia gumalamala* n. sp. holotype WAM S58479 (St Andrews Island, May). Scale bar = 2 mm.

124°59'52"E; WAM S37033 (preserved specimen), AM C471845 (4 shells), WAM S37273 (6 shells) from 15°21'36"S, 124°59'41"E; WAM S49045 (shell) from 15°21'22.7"S, 124°59'50"E; WAM S37689 (preserved specimen) from 15°21'29.5"S, 124°59'51.1"E.

Etymology

Gumalamala, name of St. George Basin and islands, including St. Andrew Island, in Worrorra, language of the Dambimangari people; noun in apposition.

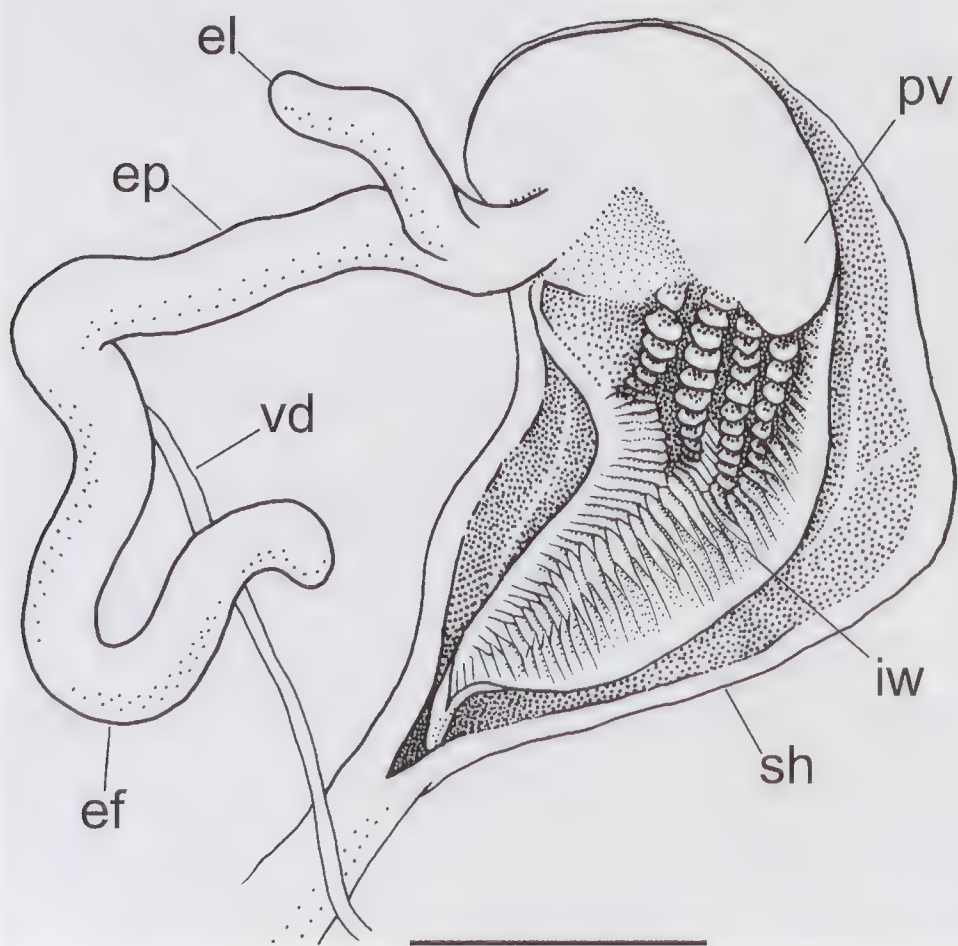


FIG. 147. Penial anatomy of *Setobaudinia gumalamala* n. sp. holotype WAM S58479 (St Andrews Island, May). Scale bar = 1 mm.

Description

Shell (Figs. 123I, 145): Small ($D = 7.7$ mm on average; Table 9), with weakly elevated spire; last whorl, periphery rounded to slightly angulated; umbilicus on average 2.0 mm wide. Protoconch ~ 1.6 mm in diameter, comprising about one whorl, with regular, strong, radially arranged pustulation. Teleoconch with faint radial growth lines extending onto base of shell and into umbilicus, inner umbilical whorls with periostracal granules, shell sparsely covered with radially arranged, pointed periostracal hairs (usually worn in adults), microscopic granules particularly prominent underneath suture and within umbilicus, and wavy axial ridglets. Last whorl weakly to moderately descending behind aperture; angle of aperture 45–60°; aperture wide, with sharp, well- to strongly expanded, weakly reflected lip, flattened at base, basal node weak or absent; palatal margin well rounded without indention, parietal wall delicate.

Genital anatomy (Figs. 146–147). Penis twice as long as vagina, rather straight. Epiphallus almost as long as penis, with long epiphallus flagellum and well-developed epiphallus lobe; two longitudinal epiphallus pilasters. Distal quarter of inner penial wall smooth, mid-portion of wall with three longitudinal rows of regularly sized, roundish pustules, proximal half with 3 longitudinal rows of densely packed, interlocking laterally elongated pustules. Anterior end of penis very thin, with weak walls. Penial verge extends about one quarter of length of penial chamber, thick, blunt. Penial retractor muscle short. Vagina tubular, elongate, about same length as free oviduct. Free oviduct moderate in length, rather straight.

Mitochondrial Differentiation

Intraspecific genetic distances (2 sequences): 0.003; interspecific genetic distances: 0.05 with respect to *S. insolita* (1 sequence), 0.123–0.124 to *S. garlinju* (2 sequences), and 0.158–0.186 to all remaining congeners (29 sequences, 10 species).

Comparative Remarks

One of the smallest species; compared to *S. hirsuta*, *S. ngurraali*, *S. umbadayi* and *S. wuyurana*, last whorl not conspicuously kinked behind aperture. These species also differ in presence of lateral pilasters at inner penial

wall rather than laterally elongated pustules. Compared to *S. garlinju* vagina much longer, penial verge much shorter, pustulation of inner umbilicus more crowded.

Distribution (Fig. 122)

St. Andrew Island.

Setobaudinia insolita n. sp.

Figs. 123J, 148–150

Type Locality

Western Australia, central Kimberley coast, Saint George Basin, St. Patrick Island, 15°21'23"S, 124°57'55"E; coll. Vince Kessner, 09/02/2009, KIS 2–64 (vine thicket on steep slopes, sandstone boulders; under rocks).

Material Examined

Holotype WAM S37690 (preserved specimen, dissected). Paratypes AM C471846 (6 shells), WAM S49044 (12 shells) from type locality.

Etymology

Derived from "*insolitus*" (Latin, masculine = unfamiliar, strange) for its unusual penial morphology; adjective of feminine gender.

Description

Shell (Figs. 123J, 148): Small ($D = 8.3$ mm on average; Table 9), with weakly elevated spire; last whorl, periphery rounded to slightly angulated; umbilicus on average 2.1 mm wide. Protoconch ~ 1.5 mm in diameter, comprising about one whorl, with regular, strong, radially arranged pustulation. Teleoconch with almost invisible, faint radial growth lines extending onto base of shell and into umbilicus, inner umbilical whorls with periostracal granules, shell densely covered with radially arranged, rather short periostracal hairs (may be worn off in adults), microscopic granules, particularly prominent underneath suture and within umbilicus, and wavy axial ridglets. Last whorl weakly to moderately descending behind aperture; angle of aperture 45–60°; aperture wide, with sharp,

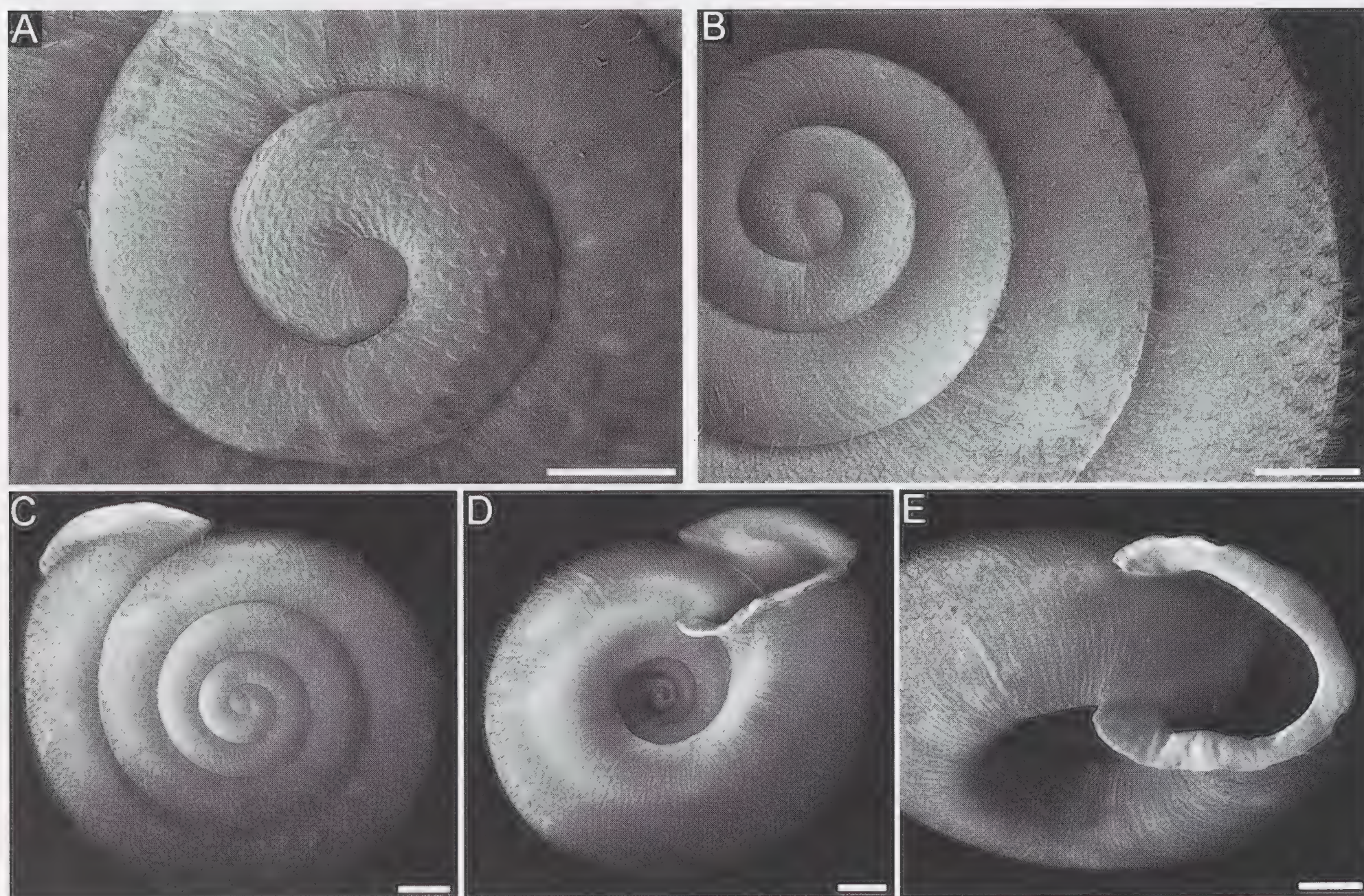


FIG. 148. SEM micrographs of the shell of *Setobaudinia insolita* n. sp. paratype AM C471846 (St Patrick Island). A: Apical view showing protoconch. Scale bar = 500 µm; B: Sculpture across entire shell viewed from above; C: Entire shell viewed from above; D: Entire shell viewed from below; E: Entire shell viewed obliquely from below showing aperture. Scale bars C–E = 1 mm.

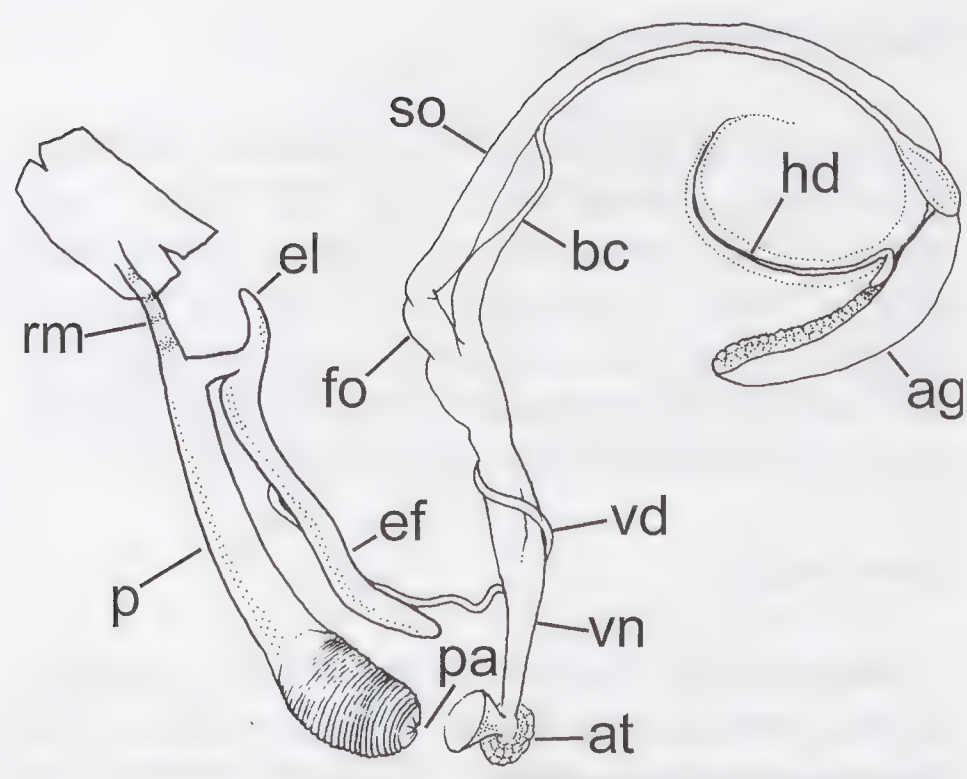


FIG. 149. Genital anatomy of *Setobaudinia insolita* n. sp. holotype WAM S37690 (St Patrick Island, February). Scale bar = 5 mm.

well- to strongly expanded, weakly reflected lip, flattened at base, basal node weak or absent; palatal margin not or weakly indented, parietal wall delicate.

Genital anatomy (Figs. 149–150): Penial complex very long (about as long as vagina, which is also very long), tubular and thin within thick penial sheath, rather straight. Epiphallus almost as long as penis, reflecting into

penial sheath as simple thin tube, with very long epiphallic flagellum and well-developed epiphallic lobe; penis proper restricted to proximal quarter of entire length of penial complex. Penial verge situated at extremely anterior position with respect to entire length of penial complex, tongue-shaped with slit-like opening. Penis proper coiled; inner wall with complex, interlocking, elongated pilasters. In illustrated specimen, penis entirely detached from atrium. Vagina tubular, much longer than free oviduct.

Mitochondrial Differentiation

Interspecific genetic distances (1 sequence): 0.05 with respect to *S. gumalamala* (2 sequences), 0.13 to *S. garlinju* (2 sequences), and 0.158–0.186 to all remaining congeners (29 sequences, 10 species).

Comparative Remarks

One of the smallest species of the genus; in contrast to *S. hirsuta*, *S. ngurraali*, *S. umbadayi* and *S. wuyurana*, last whorl not conspicuously kinked behind aperture. Most conspicuous features are penis with reflexing epiphallus, proximally located, tongue-like penial verge, and short penis proper with complex

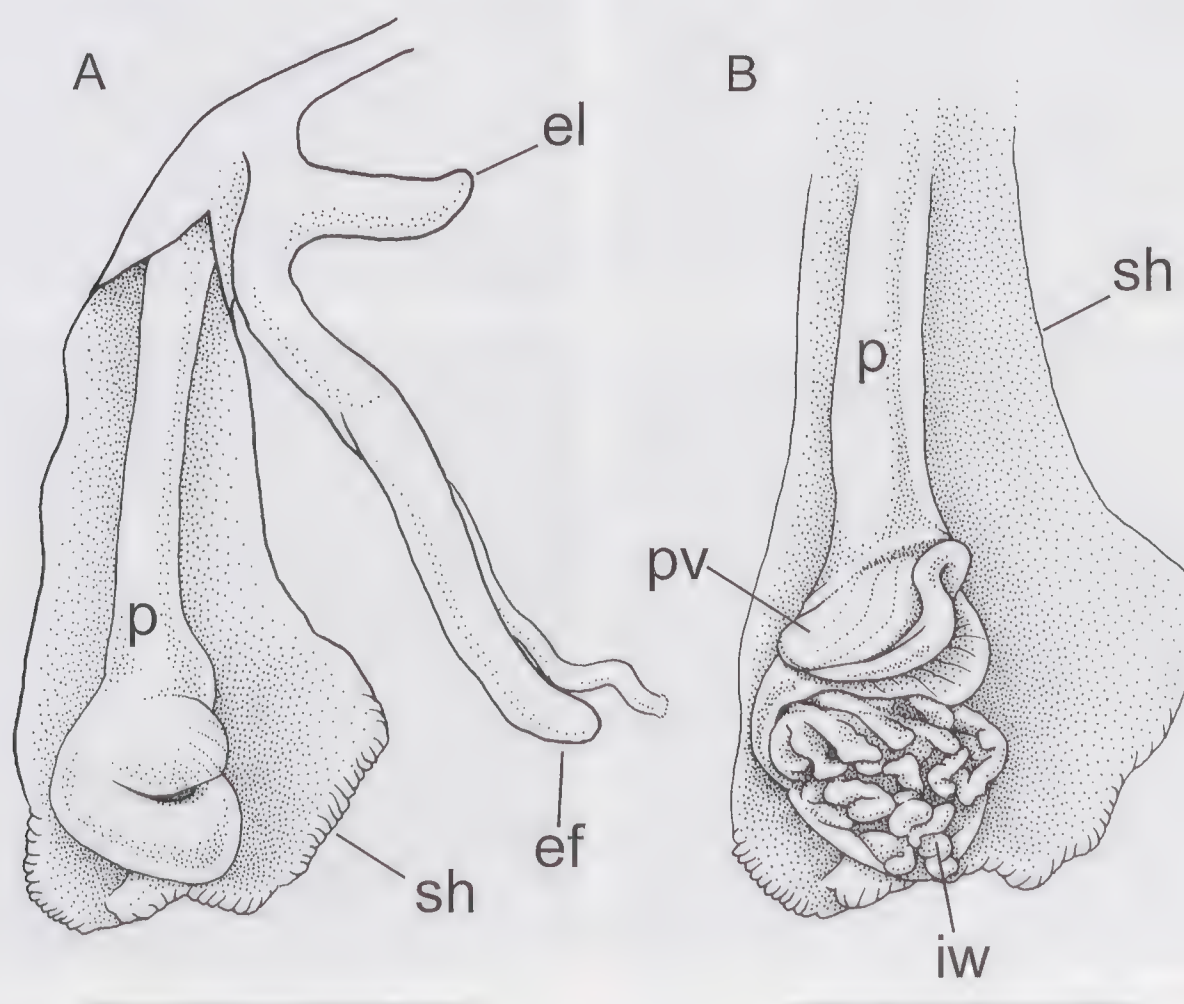


FIG. 150. Penial anatomy of *Setobaudinia insolita* n. sp. holotype WAM S37690 (St Patrick Island, February). A: Penis within opened penial sheath. Scale bar = 2 mm; B: Internal penial anatomy showing penial verge and complex penial wall pustulation. Scale bar = 1 mm.

interlocking penial wall pilaster plus extremely long vagina. It is not known whether complete detachment of penis is typical for this species. This feature is found also in other species, possibly depending on reproductive or developmental status of specimen.

Distribution (Fig. 122)

St. Patrick Island.

***Setobaudinia quinta* n. sp.**

Figs. 123K, 151–153

Type Locality

Western Australia, southwestern Kimberley, Doubtful Bay, SE section of Storr Island, 15°56'54"S, 124°33'32"E; coll. Vince Kessner, 24/05/2009, KIS 3–148 (large rocky outcrop in vine thicket at base of sandstone cliffs; under rocks in loose soil).

Material Examined

Holotype WAM S58480 (preserved specimen, dissected). Paratypes WAM S37729 (3 preserved specimens), WAM S37891 (17 shells), AM C471847 (10 shells), WAM S37794 (2 preserved specimens), WAM S37889 (50 shells), AM C471848 (23 shells), WAM S37890 (shell), WAM S37888 (4 shells) from type locality.

Etymology

Derived from “*quinta*” (Latin = fifth), referring to the manuscript name “*Setobaudinia* NSP 5” used by Solem (1991) for material from the Doubtful Bay area and further south, which is believed to be at least in part conspecific.

Description

Shell (Figs. 123K, 151): Small ($D = 6.7$ mm on average; Table 9), nearly discoidal with weakly

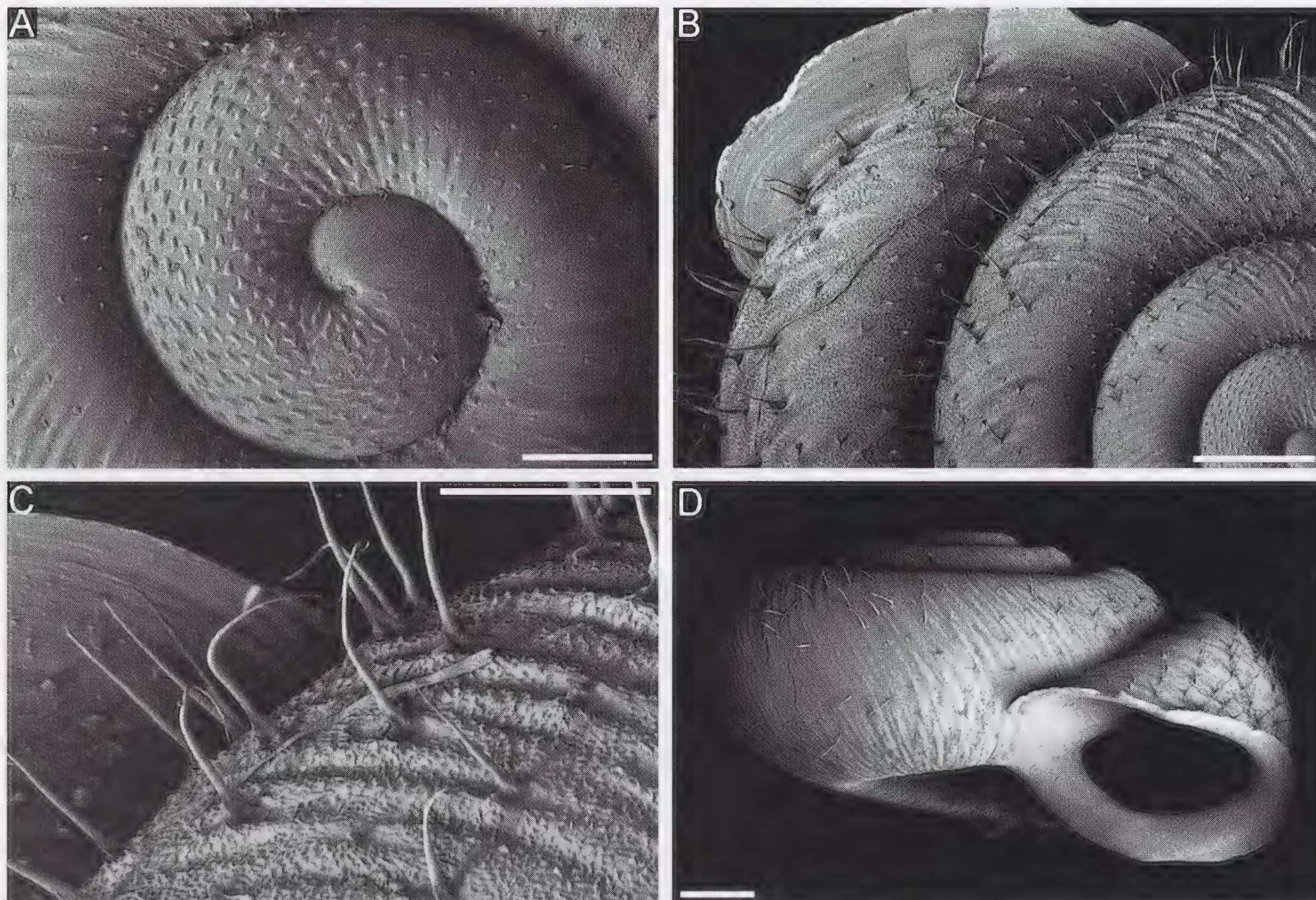


FIG. 151. SEM micrographs of the shell of *Setobaudinia quinta* n. sp. paratype AM C471847 (Storr Island). A: Apical view showing protoconch; B: Sculpture across entire shell viewed from above; C: Close-up of periostracal hairs on penultimate whorl; D: Frontal view of entire shell showing aperture. Scale bars A, C = 500 µm; B, D = 1 mm.

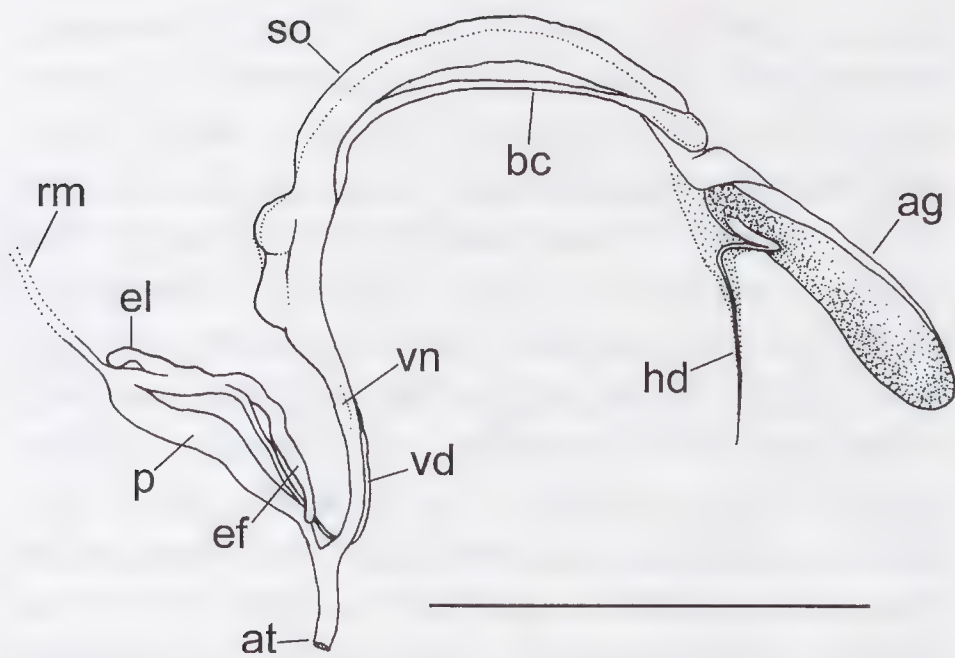


FIG. 152. Genital anatomy of *Setobaudinia quinta* n. sp. holotype WAM S58480 (Storr Island, May). Scale bar = 5 mm.

elevated spire; periphery rounded to slightly angulated; umbilicus on average 1.7 mm wide, not concealed; colour light yellowish brownish. Protoconch about 1.6 mm in diameter, comprising about one whorl, with regular, strong, radially arranged pustulation. Teleoconch with almost invisible, faint radial growth lines extending onto base of shell and into umbilicus, inner umbilical whorls with periostracal granules, shell sparsely covered with radially arranged, pointed and thin periostracal hairs (usually worn in adults),

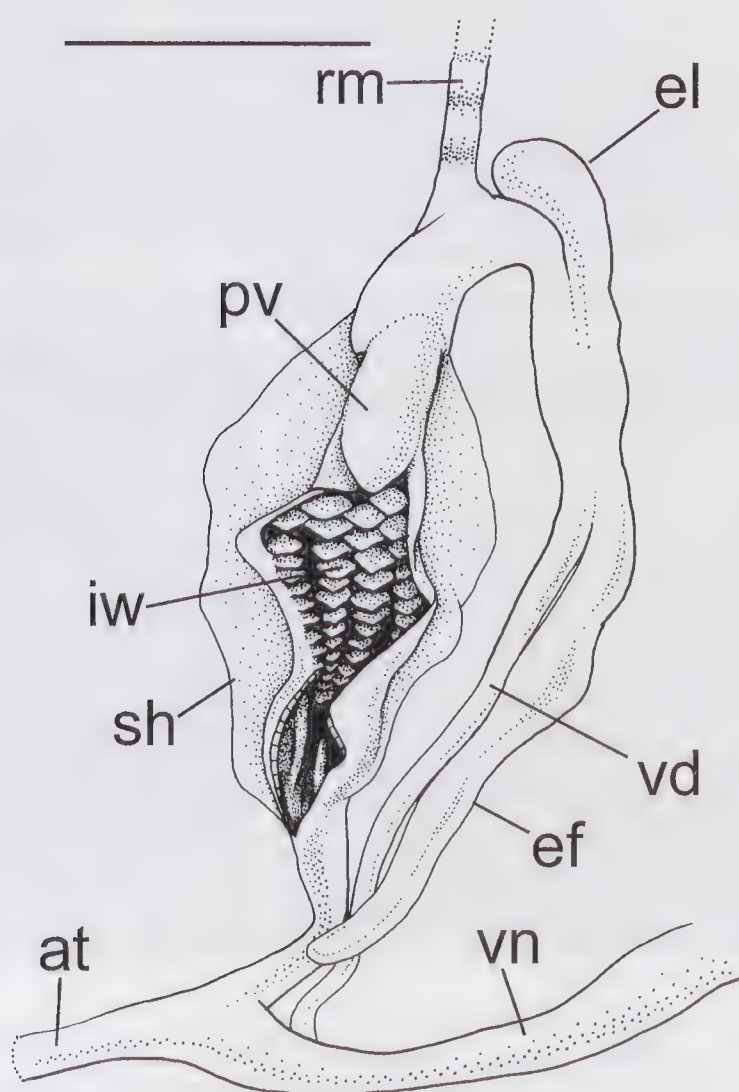


FIG. 153. Penial anatomy of *Setobaudinia quinta* n. sp. holotype WAM S58480 (Storr Island, May). Scale bar = 1 mm.

microscopic granules particularly prominent underneath suture and within umbilicus. Last whorl weakly to moderately descending behind aperture; angle of aperture 45–60°; aperture wide, with sharp, moderately expanded, weakly reflected lip, flattened at base, basal node weak or absent; palatal margin not or weakly indented, parietal wall delicate.

Genital anatomy (Figs. 152–153): Penis moderately long (about same length as vagina), rather straight. Epiphallus almost as long as penis, with moderately long epiphallic flagellum and well-developed epiphallic lobe; interiorly with one thin longitudinal epiphallic pilaster. Inner penial wall with longitudinal rows of triangular pustules that taper in size towards proximal end, giving rise to thin longitudinal pilasters at proximal end of penial wall. Penial verge extending about one quarter of length of penial chamber, thick, blunt. Vagina tubular, elongate, longer than free oviduct.

Mitochondrial Differentiation

Intraspecific genetic distance (2 sequences): 0.004; interspecific genetic distances: 0.155–0.186 to all congeners (33 sequences, 12 species).

Comparative Remarks

Smallest species of the genus. Shell with indistinct axial ribbing and comparatively sparse pustulation. Characteristic penial wall anatomy with longitudinal rows of triangular pustules that taper in size.

Distribution (Fig. 122)

Storr Island and likely adjacent areas on mainland at Doubtful Bay.

Setobaudinia joycei n. sp. Figs. 123L, 154–156

Type Locality

Western Australia, southwestern Kimberley, Collier Bay, Wulalam Island, 16°22'13.4"S, 124°13'46.7"E; coll. Sean Stankowski, 22/05/2009, KIS 2–73 (cliff face with scree, base of creek line, in leaf litter between rocks).

Material Examined

Holotype WAM S58481 (preserved specimen). Paratypes WAM S37780 (12 preserved speci-

mens), WAM S37779 (7 preserved specimens), AM C471849 (5 preserved specimens), WAM S37884 (8 shells), WAM S37885 (5 shells), AM C471850 (5 shells), WAM S37781 (7 preserved specimens), WAM S37782 (4 preserved specimens), WAM S37886 (3 shells), WAM S37783 (preserved specimen, dissected), WAM S49265 (3 preserved specimens) from Wulalam Island.

Etymology

Named in honour of my friend Michael Joyce (Sydney), who runs the most wonderful barber shop in town; noun in genitive case.

Description

Shell (Figs. 123L, 154): Small ($D = 8.3$ mm on average; Table 9), nearly discoidal with weakly elevated spire; periphery rounded to slightly angulated; umbilicus on average 2.5 mm wide,

not concealed; colour light yellowish brownish. Protoconch about 1.5 mm in diameter, comprising about one whorl, with regular, strong, radially arranged pustulation. Teleoconch with faint radial growth lines extending onto base of shell and into umbilicus, inner umbilical whorls with periostracal granules, shell sparsely covered with radially arranged, pointed periostracal hairs (usually worn off in adults), microscopic granules, particularly prominent underneath suture and within umbilicus. Last whorl weakly to moderately descending behind aperture; angle of aperture $45\text{--}60^\circ$; aperture wide, with sharp, moderately expanded, weakly reflected lip, flattened at base, basal node weak or absent; palatal margin weakly indented, parietal wall delicate.

Genital anatomy (Figs. 155–156): Penis extremely long and thick (twice as long as vagina), coiled within diaphanous penial sheath. Epiphallus almost as long as penis, attached to penis by connective tissue, with comparatively

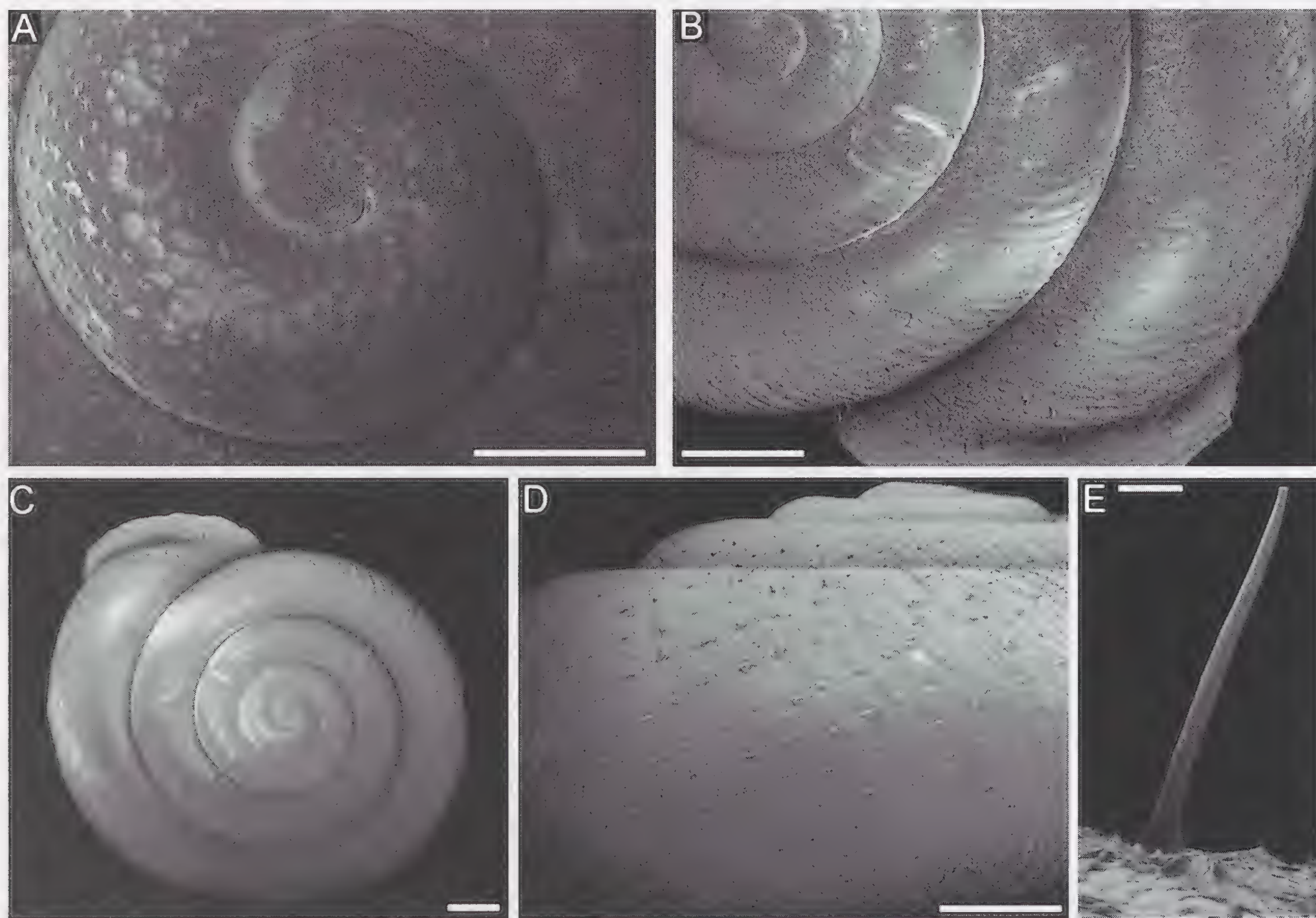


FIG. 154. SEM micrographs of the shell of *Setobaudinia joycei* n. sp. paratype AM C471850 (Wulalam Island). A: Apical view showing protoconch. Scale bar = 500 μm ; B: Sculpture across entire shell viewed from above; C: Entire shell viewed from above; D: Lateral view of last whorl showing distribution of periostracal hairs across whorl surface. Scale bars B–D = 1 mm; E: Close-up of periostracal hair. Scale bar = 100 μm .

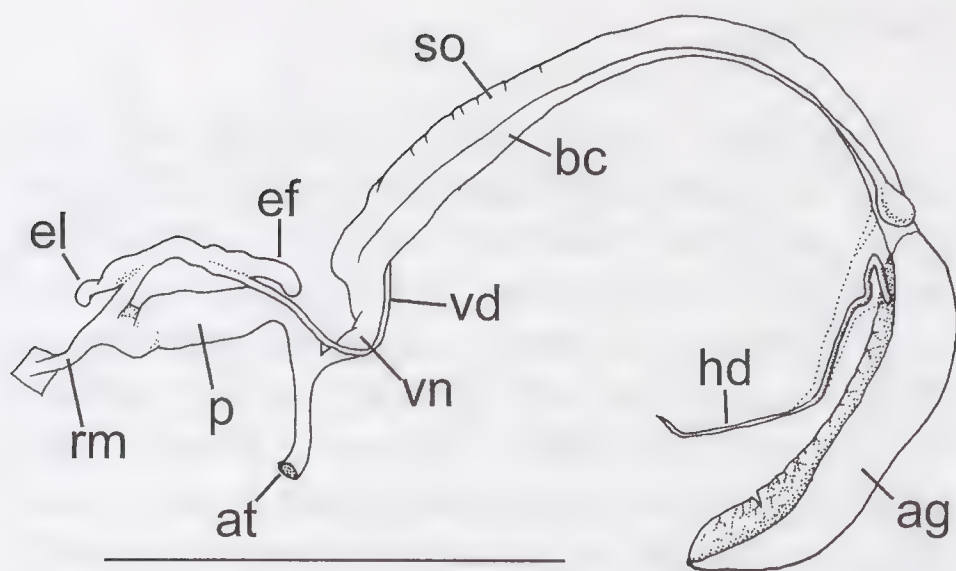


FIG. 155. Genital anatomy of *Setobaudinia joycei* n. sp. holotype WAM S58481 (Wulalam Island, May). Scale bars = 3 mm.

short epiphallic flagellum and epiphallic lobe; interiorly with one thick longitudinal epiphallic pilaster. Inner penial wall with very indistinct, obliquely transverse pilasters. Penial verge extends about one third penial chamber, thick, conical. Vagina tubular, elongate, short, longer than free oviduct.

Mitochondrial Differentiation

Intraspecific genetic distance (2 sequences): 0.006; interspecific genetic distances: 0.064–0.70 with respect to *S. karczewski* (3 sequences), 0.155–0.182 to all congeners (30 sequences, 11 species).

Comparative Remarks

Illustrated dissection with conspicuously elongated atrium. However, atrium was much shorter in second dissected specimen. Typical for this species is comparative large size of penis, coiling within penial sheath and oblique sculpture of inner penial wall (absence of pustules or lamellae). In addition, relatively widely spaced and sparsely distributed periostracal hairs are typical. When not worn, hairs are comparatively long.

Distribution (Fig. 122)

Wulalam Island.

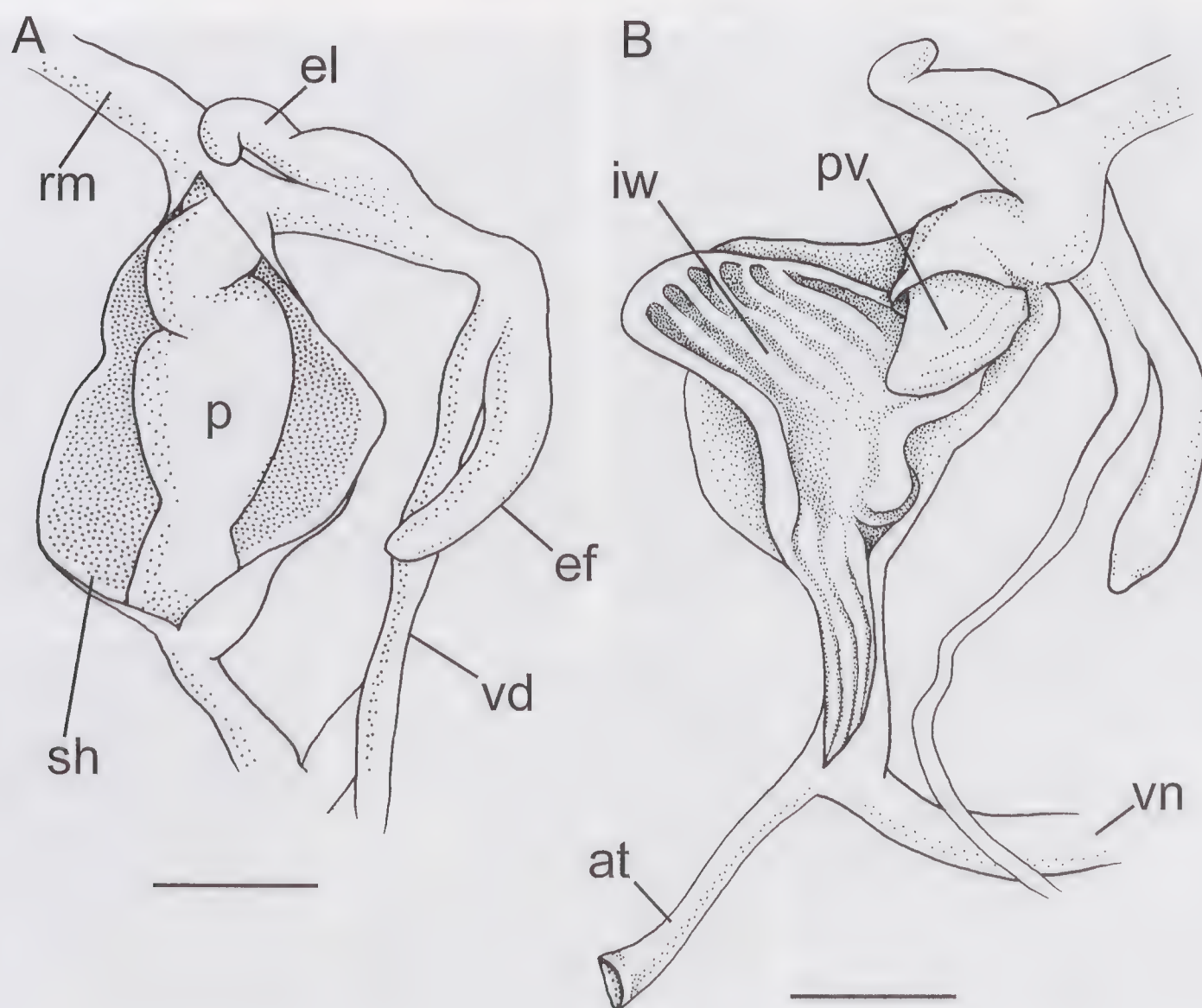


FIG. 156. Penial anatomy of *Setobaudinia joycei* n. sp. holotype WAM S58481 (Wulalam Island, May). A: Penis within opened penial sheath; B: Internal penial anatomy showing penial verge and inner wall sculpture. Scale bars = 1 mm.

***Setobaudinia karczewski* n. sp.**

Figs. 123M, 157–159

Type Locality

Western Australia, southwestern Kimberley, Buccaneer Archipelago, Talbot Bay, N section of Molema Island, 16°15'09.7"S, 123°49'11.7"E; coll. Sean Stankowski, 27/05/2009, KIS 2–79 (rock scree in gully with vine thicket elements; between rocks in soil and litter).

Material Examined

Holotype WAM S58482 (preserved specimen, dissected). Paratypes WAM S37784 (7 preserved specimens), WAM S37887 (3 shells), WAM S49266 (6 preserved specimens), AM C471851 (5 preserved specimens) from N section of Molema Island.

Etymology

Named in honour of Elke Karczewski (Berlin); noun in apposition.

Description

Shell (Figs. 123M, 157): Small ($D = 8$ mm; Table 9), nearly discoidal with weakly elevated spire; periphery rounded to slightly angulated; umbilicus 1.5 mm wide, not concealed. Protoconch about 1.5 mm in diameter, comprising about one whorl, with regular, strong, radially arranged pustulation. Teleoconch with faint radial growth lines extending onto base of shell and into umbilicus, inner umbilical whorls with periostracal granules, shell sparsely covered with radially arranged, pointed periostracal hairs (usually worn in adults), microscopic granules, particularly prominent underneath suture and within umbilicus. Last whorl weakly to moderately descending behind aperture; angle of aperture 45–60°; aperture wide, with sharp, moderately expanded, weakly reflected lip, flattened at base, basal node weak or absent; palatal margin weakly indented, parietal wall delicate.

Genital anatomy (Figs. 158–159): Penis moderately long (about same length as vagina), straight. Epiphallus almost as long as penis,

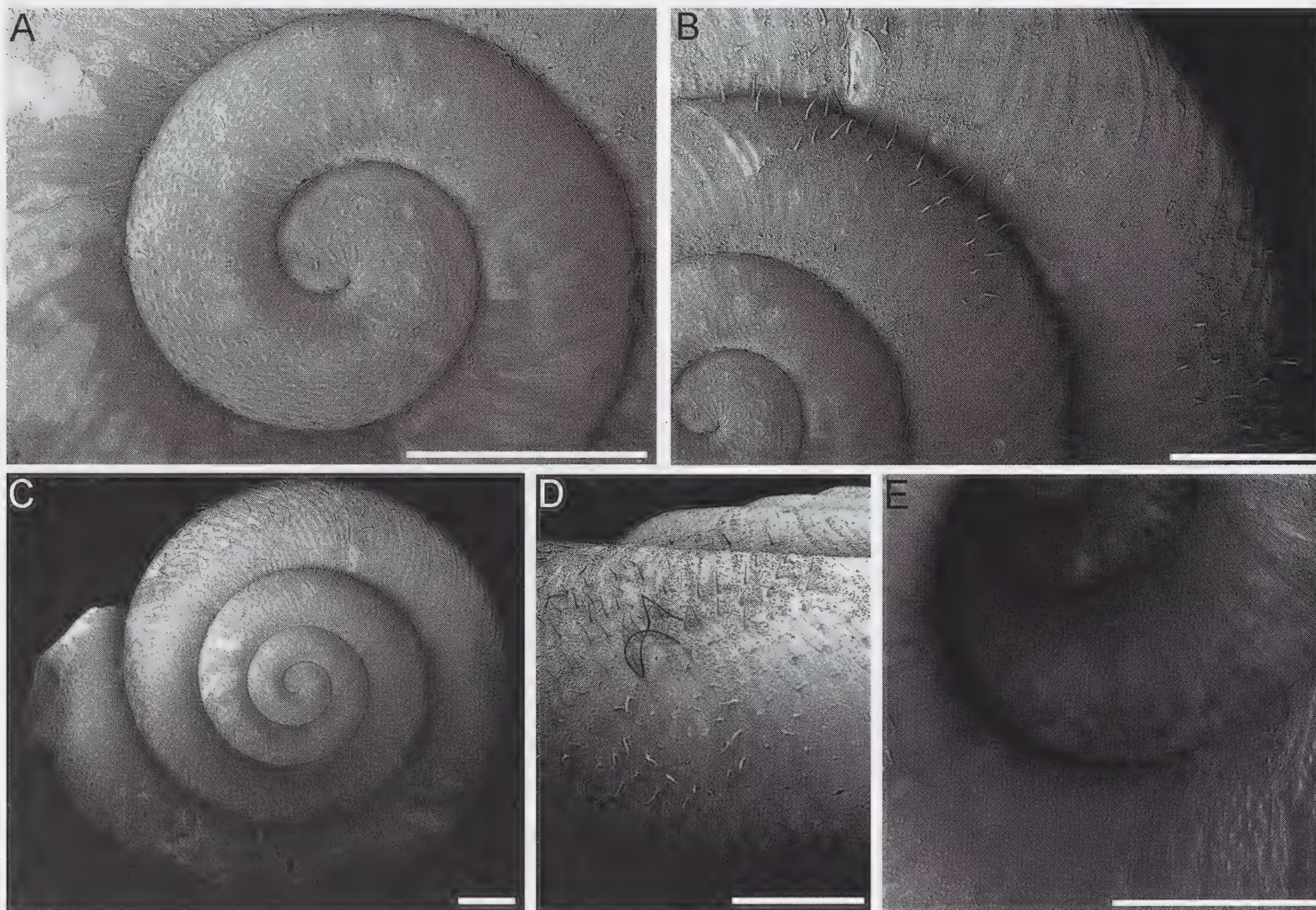


FIG. 157. SEM micrographs of the shell of *Setobaudinia karczewski* n. sp. paratype WAM S37887 (Molema Island). A: Apical view showing protoconch; B: Sculpture across entire shell viewed from above; C: Entire shell viewed from above; D: Lateral view of last whorl showing distribution of periostracal hairs across whorl surface; E: Umbilicus. Scale bars = 1 mm.

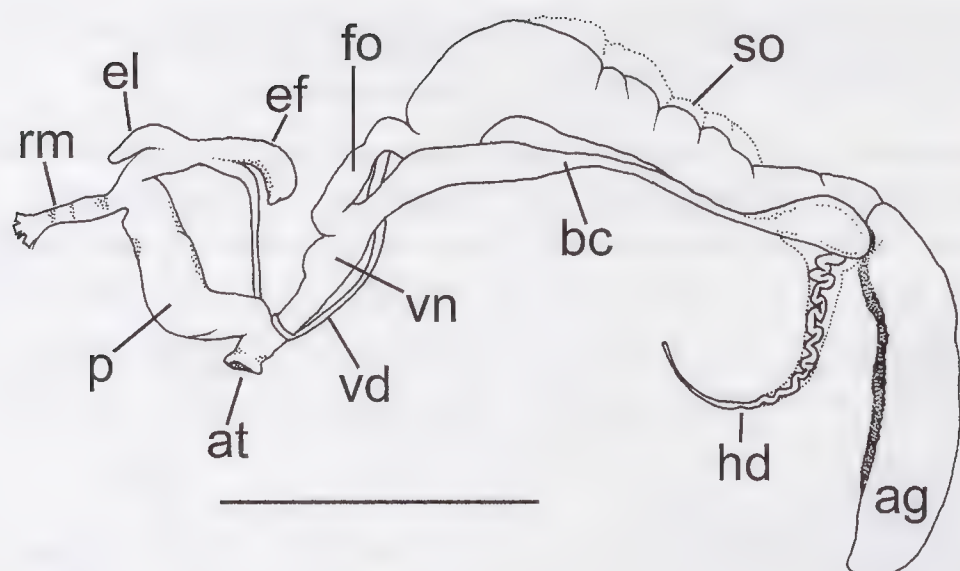


FIG. 158. Genital anatomy of *Setobaudinia karczewski* n. sp. holotype WAM S58482 (Molema Island, May). Scale bar = 5 mm.

with comparatively short epiphallus flagellum and epiphallus lobe; interiorly with one thick longitudinal epiphallus pilaster. Inner penial wall with well-developed, crowded, longitudinal pilasters comprising entire length of penial wall. Penial verge extending about half of penial chamber, thick, conical. Vagina tubular, elongate, about same length as free oviduct. Free oviduct comparatively long.

Mitochondrial Differentiation

Intraspecific genetic distance (3 sequences): 0.008–0.025; interspecific genetic distances: 0.064–0.70 with respect to *S. joycei* (2 se-

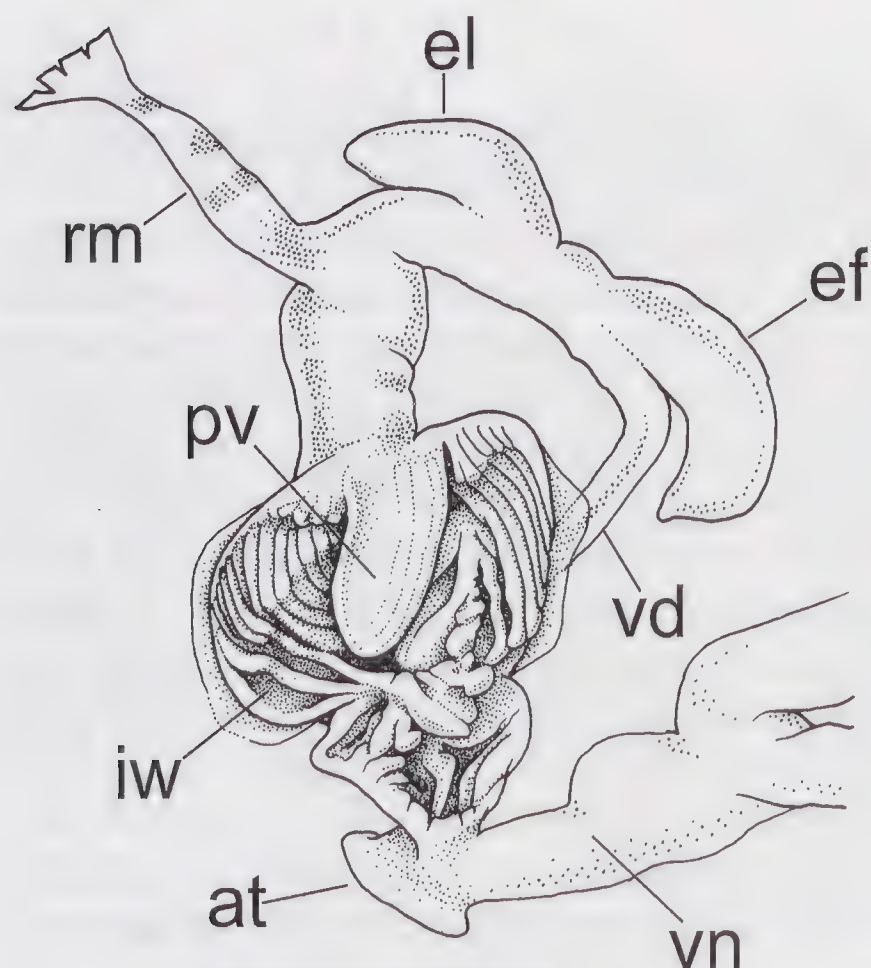


FIG. 159. Penial anatomy of *Setobaudinia karczewski* n. sp. holotype WAM S58482 (Molema Island, May). Scale bar = 2 mm.

quences), 0.155–0.180 to all congeners (30 sequences, 11 species).

Comparative Remarks

Inner penial wall sculpture consisting of many crowded longitudinal pilasters is most typical.

Distribution (Fig. 122)

Molema Island.

Torresitrachia Iredale, 1939

Torresitrachia Iredale, 1939: 48–49; Solem, 1979: 45–92; 1985a: 922–933 (partim), 1991: 178–185 (partim); Solem & McKenzie, 1991: 247–263 (partim); Willan et al., 2009: 87–102. Type species: *Helix endeavourensis* Brazier, 1872, by original designation.

Taxonomic Remarks

Solem (1979) revised the nomenclatural history and pointed out that the taxon was validly described by Iredale (1939), although being mentioned earlier by Iredale (1933, 1938) as *nomen dubium*. The type species, *Helix endeavourensis* is currently considered as junior synonym of *Helyx torresiana* Hombron & Jacquinot, 1841, from Cape York. Solem (1979) also demonstrated that general morphology of Western Australian species corresponds well with the type species from tropical Queensland. In addition, he listed *Magitrachia* Iredale, 1941 (type species *Planispira (Trachiopsis) blackiana* Preston, 1905, from Port Moresby, Papua New Guinea), as a synonym for its similar shell. Given rampant parallelism in the shell of Australian Camaenidae, I do not reiterate this suggestion but remark that the status of *Magitrachia* remains to be clarified.

Species exhibiting a penial anatomy that deviate from the diagnosis presented here are transferred to a new genus, *Kimberleytrachia* (see below). This treatment is well supported by molecular phylogenetic data (Köhler, 2009, 2010c) showing that both taxa form distinct clades that are not in a sister taxon relationship.

Diagnosis

Shell: Medium sized ($D = 12\text{--}20$ mm; Table 10), discoidal to broadly conical with sunken to slightly elevated spire, moderately increasing whorls separated by well-incised suture and

TABLE 10. Shell parameters of *Torresitrachia* (in mm), given are maximum – minimum (mean $\pm$ standard deviation) for N measured specimens. Abbreviations used: HT = holotype.

Species	N	Height (H)	Diameter (D)	Umbilicus (U)	Whorls	H/D Ratio
<i>T. aquilonia</i> n. sp.	HT	8.0	16.0	2.5	4.25	0.50
	17	7.2–8.5 (7.8 $\pm$ 0.4)	14.5–16.6 (15.5 $\pm$ 0.6)	2.4–2.9 (2.6 $\pm$ 0.1)	4.0–4.3 (4.1 $\pm$ 0.1)	0.46–0.53 (0.50 $\pm$ 0.02)
<i>T. eclipsis</i> n. sp.	HT	8.8	15.6	2.7	4.4	0.56
	18	7.5–9.5 (8.2 $\pm$ 0.6)	13.0–16.5 (14.6 $\pm$ 1.0)	2.0–2.7 (2.3 $\pm$ 0.2)	4.1–4.5 (4.3 $\pm$ 0.2)	0.53–0.59 (0.56 $\pm$ 0.02)
<i>T. janszi</i> n. sp.	HT	10.0	19.2	2.8	4.6	0.52
	5	10.0–10.8 (10.3 $\pm$ 0.3)	17.8–19.5 (18.7 $\pm$ 0.7)	2.6–3.1 (2.9 $\pm$ 0.2)	4.1–4.7 (4.5 $\pm$ 0.2)	0.52–0.59 (0.55 $\pm$ 0.02)
<i>T. urvillei</i> n. sp.	HT	9.5	15.3	1.8	4.3	0.62
	17	7.3–10.0 (8.7 $\pm$ 0.7)	12.7–17.6 (15.0 $\pm$ 1.2)	1.5–2.2 (2.0 $\pm$ 0.2)	3.8–4.7 (4.3 $\pm$ 0.2)	0.55–0.64 (0.58 $\pm$ 0.02)
<i>T. brookei</i> n. sp.	HT	7.7	13.8	1.7	4.1	0.56
	10	7.1–9.6 (8.0 $\pm$ 0.6)	12.2–17.3 (14.2 $\pm$ 1.4)	1.5–2.5 (1.9 $\pm$ 0.3)	4.1–4.3 (4.2 $\pm$ 0.1)	0.53–0.61 (0.56 $\pm$ 0.02)
<i>T. allouarni</i> n. sp	HT	7.2	14.5	2.9	4.3	0.50
	12	6.4–8.1 (7.1 $\pm$ 0.4)	13.8–16.3 (14.7 $\pm$ 0.7)	2.5–3.0 (2.7 $\pm$ 0.2)	4.2–4.7 (4.3 $\pm$ 0.1)	0.40–0.52 (0.48 $\pm$ 0.03)
<i>T. flindersi</i> n. sp	HT	7.1	14.5	2.7	4.25	0.49
	13	5.8–7.1 (6.6 $\pm$ 0.4)	12.8–15.7 (14.4 $\pm$ 0.8)	2.2–3.0 (2.7 $\pm$ 0.2)	3.8–4.3 (4.1 $\pm$ 0.1)	0.43–0.50 (0.46 $\pm$ 0.02)
<i>T. baudini</i> n. sp.	HT	7.5	16.0	3.0	4.4	0.47
	19	7.1–9.0 (8.0 $\pm$ 0.5)	14.8–17.5 (15.9 $\pm$ 0.6)	2.5–3.2 (2.8 $\pm$ 0.2)	4.3–4.7 (4.5 $\pm$ 0.1)	0.46–0.54 (0.51 $\pm$ 0.02)
<i>T. tasmani</i> n. sp.	HT	9.2	17	3.1	4.6	0.54
	15	8.0–9.8 (8.8 $\pm$ 0.5)	15.9–19.0 (17.2 $\pm$ 0.9)	2.5–3.5 (3.1 $\pm$ 0.3)	4.4–4.8 (4.6 $\pm$ 0.1)	0.48–0.54 (0.50 $\pm$ 0.02)
<i>T. freycineti</i> n. sp.	HT	6.7	15	3.0	4.3	0.45
	19	5.5–8.0 (6.9 $\pm$ 0.6)	12.0–16.5 (14.8 $\pm$ 1.1)	2.5–3.6 (2.9 $\pm$ 0.3)	4.0–4.5 (4.3 $\pm$ 0.2)	0.44–0.53 (0.47 $\pm$ 0.02)
<i>T. houtmani houtmani</i> n. sp.	HT	8.5	15.8	2.6	4.0	0.54
	20	7.2–10.5 (9.4 $\pm$ 0.7)	13.9–18.0 (16.4 $\pm$ 1.0)	1.8–3.0 (2.3 $\pm$ 0.3)	3.8–4.7 (4.3 $\pm$ 0.2)	0.52–0.62 (0.57 $\pm$ 0.03)
<i>T. houtmani dampieri</i> n. sp.	HT	9.0	16.4	2.6	4.5	0.55
	26	8.4–10.6 (9.6 $\pm$ 0.6)	15.8–18.8 (17.5 $\pm$ 0.8)	2.3–3.0 (2.6 $\pm$ 0.2)	4.1–4.7 (4.4 $\pm$ 0.2)	0.51–0.62 (0.55 $\pm$ 0.03)
<i>T. leichhardti</i> n. sp.	HT	7.0	14.6	2.7	4.1	0.48
	19	5.9–7.7 (6.9 $\pm$ 0.5)	12.1–15.4 (14.1 $\pm$ 0.9)	2.0–3.0 (2.5 $\pm$ 0.3)	3.8–4.7 (4.2 $\pm$ 0.2)	0.45–0.52 (0.49 $\pm$ 0.02)
<i>T. hartogi</i> n. sp.	HT	8.5	17.9	3.1	4.3	0.47
	11	8.0–9.5 (8.8 $\pm$ 0.4)	16.2–18.5 (17.3 $\pm$ 0.7)	2.4–3.2 (2.9 $\pm$ 0.2)	4.3–4.7 (4.5 $\pm$ 0.1)	0.47–0.56 (0.51 $\pm$ 0.03)
<i>T. girgarinae</i> n. sp.	3	6.3–7.1 (6.7 $\pm$ 0.3)	13.1–14.2 (13.5 $\pm$ 0.5)	2.0–2.7 (2.4 $\pm$ 0.3)	3.8–4.1 (4.0 $\pm$ 0.1)	0.48–0.51 (0.50 $\pm$ 0.01)

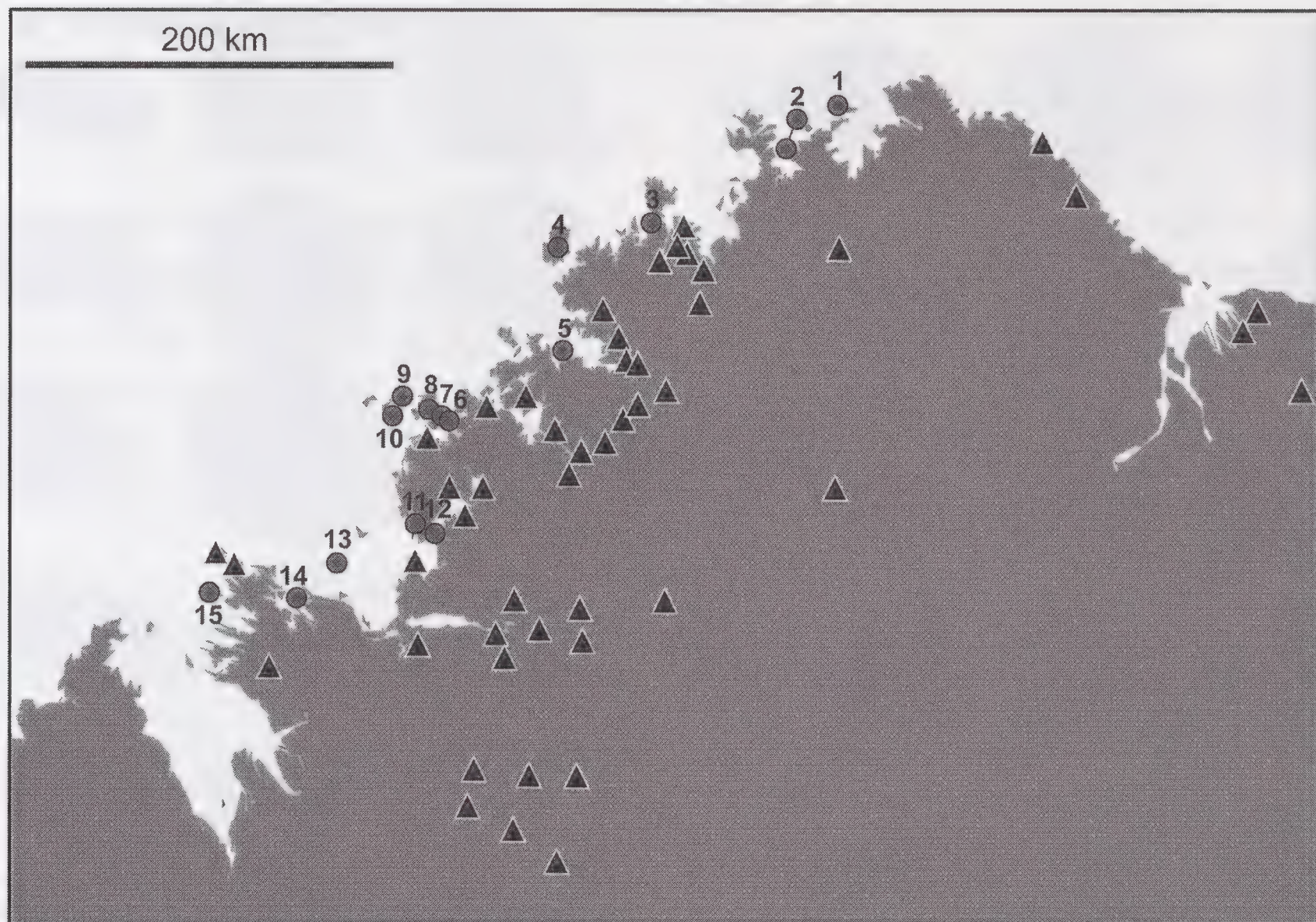


FIG. 160. Distribution map of *Torresitrachia* in the Kimberley. Circles = records of species treated herein: 1: *T. aquilonia* n. sp. (Sir Graham Moore Island), 2: *T. eclipsis* n. sp. (Eclipse Archipelago, Long and Jar Islands), 3: *T. janszi* n. sp. (Katers Island), 4: *T. urvillei* n. sp. (Bigge Island), 5: *T. brookei* n. sp. (Boongaree Island), 6: *T. baudini* n. sp. (unnamed islet SE of Augustus Island), 7: *T. allouarni* n. sp. (SE Augustus Island), 8: *T. flindersi* n. sp. (NW Augustus Island), 9: *T. freycineti* n. sp. (D'Arcy Island), 10: *T. tasmani* n. sp. (Byam Martin Island), 11: *T. houtmani houtmani* n. sp. & n. subsp. (unnamed island, Doubtful Bay), 12: *T. leichhardti* n. sp. (Storr Island), 13: *T. houtmani dampieri* n. subsp. (Kingfisher Island), 14: *T. hartogi* n. sp. (Molema Island), 15: *T. girgarinae* n. sp. (Hidden Island); triangles = records of various species listed by Solem (1979, 1985, 1991).

well-rounded periphery; umbilicus moderately open to nearly closed, partly concealed; protoconch with very weak to strongly developed, radially elongated pustulation; teleoconch mostly with well-developed axial ribs, usually extending onto base of shell but not into umbilicus; in some species with periostracal hairs or spines, and more or less developed pustulose microsculpture consisting of vertical, angled or spiral ridglets (frequently restricted to subsutural part of whorls), umbilical walls sparsely to densely covered by periostracal pustulation. Shell colour uniform, yellowish brown to brown. Last whorl not or weakly descending behind aperture; angle of aperture $\sim 60^\circ$. Aperture slightly to strongly deflected from axis of coiling, partly covering umbilicus, with simple to slightly protruded basal lip and very thin parietal callus.

Genital anatomy: Penis without penial sheath, embedded in connective tissue; epiphallus well developed, with short to well-developed epiphallic flagellum. Inner penial wall with strongly developed, rhomboid pustules distally and longitudinal pilasters proximally. Penial retractor muscle attached at mid-portion of epiphallus. Epiphallus opens to penial lumen through constricting vergic ring. Inner epiphallic wall with longitudinal pilasters that vary in number and development, pustulation occasionally present; vas deferens opens through slit-like, valvular opening into epiphallus. Bursa copulatrix elongate, tubular, extending to anterior end of albumen gland.

Aestivation Strategy

Free sealer (modified after Solem, 1985a).

Comparative Remarks

Torresitrachia is characterized by combination of rather small to moderate shell size, discoidal to broadly conical shape, regular and conspicuous ribbing (only exceptionally ribs are weak and well-developed hairs are present, such as in *Torresitrachia alenae* Willan, Köhler; Kessner & Braby, 2009) and a narrowly winding, essentially unconcealed umbilicus. Typical combination of genital characters are: lack of penial sheath, presence of well-developed epiphallus with flagellum, separation of epiphallic and penial lumen by constricting, circular vergic ring, tubular bursa copulatrix extending until anterior end of albumen gland, inner penial wall with pustulation distally and longitudinal pilasters proximally. Species previously affiliated with *Torresitrachia* that differ from this typical anatomy by having relatively large but delicate shells with pustulose microsculpture, a strongly descending last whorl (rock sealers) and formation of lateral lamellae at distal end of inner penial wall (instead of rhomboid pustules) form a distinct, monophyletic group and are transferred to the new genus ***Kimberleytrachia*** described below. Due to conserved shell morphology, most *Torresitrachia* species are distinguishable by their genital anatomy only.

Diversity and Distribution (Fig. 160)

Torresitrachia ranges across the tropical north of Australia from the Torres Strait, northern Queensland in the east to the southwest Kimberley in the west, although currently no species are known from the Gulf of Carpentaria area. As delimited by Solem (1979) to include as *Magitrachia* Iredale, 1941, a junior synonym, the taxon also occurs in Papua New Guinea. However, this assumption requires confirmation by comparative study of suitable material from that region. The highest diversity is found in western parts of the range with six out of eleven previously known species occurring in the Kimberley plus four in northern parts of the Northern Territory, between Kununurra and Katherine (this does not include species herein assigned to ***Kimberleytrachia***, n. gen.). Only one species is currently recognized from Cape York. Herein, 15 species are newly described, all of which are narrowly endemic to an island or even only parts of islands. Based on observation that shell morphology of most species is rather conserved and that species ranges are usually small, I predict that there is a high proportion of undiscovered species across the entire range of the genus.

Torresitrachia aquilonia n. sp.
Figs. 161A, 162–164

Type Locality

Western Australia, northern Kimberley, Eclipse Archipelago, eastern section of Sir Graham Moore Island, 13°53'51"S, 126°35'53"E; coll. Vince Kessner, 9/08/2007, KIS 3–40 (patches of vine thicket on dunes, under logs in loose soil).

Material Examined

Holotype. WAM S58451 (preserved specimen, Fig. 161A). Paratypes AM C471757 (20 preserved specimens), WAM S36632 (29 preserved specimens), AM C471758 (20 shells), WAM S36438 (47 shells) from type locality; WAM S36633 (16 preserved specimens), WAM S36565 (10 shells) from 13°54'05"S, 126°35'51"E; WAM S36631 (13 preserved specimens), WAM S36437 (2 shells) from 13°53'56"S, 126°35'59"E; WAM S36452 (16 shells) from 13°54'14"S, 126°36'01"E; WAM S36959 (20 shells) from 13°53'50"S, 126°35'51"E; AM C471759 (10 shells), WAM S36960 (20 shells) from 13°54'06.2"S, 126°35'53.4"E.

Etymology

From "*aquilonia*" (Latin = northern), for being the northernmost species of *Torresitrachia* currently known from the Kimberley, adjective of feminine gender.

Description

Shell (Figs. 161A, 162A–D): Moderate in size ($D = 14.5\text{--}16.6$ mm; Table 10), nearly discoidal with low spire; umbilicus ~ 2.5 mm wide; colour light brownish-horn, with glossy surface. Protoconch ~ 2.3 mm in diameter, comprising about 1.5 whorls, essentially smooth. Teleoconch with regularly and narrowly spaced radial ribs; inner umbilical whorls with microsculpture of fine periostracal extensions. Apertural lip sharp, well- to strongly expanded, slightly reflected, well rounded, without nodes, parietal wall extremely delicate.

Digestive anatomy (Fig. 162E–G): Jaw consisting of many plates. Radula 4 mm long, with about 150 rows of teeth; $C + 13\text{--}14 + 2\text{--}3 + 18\text{--}20$ ($n = 1$).

Genital anatomy (Figs. 163–164): Penis shorter than vagina, bent or coiled. Epiphallus coiled, almost as long as penis, with short

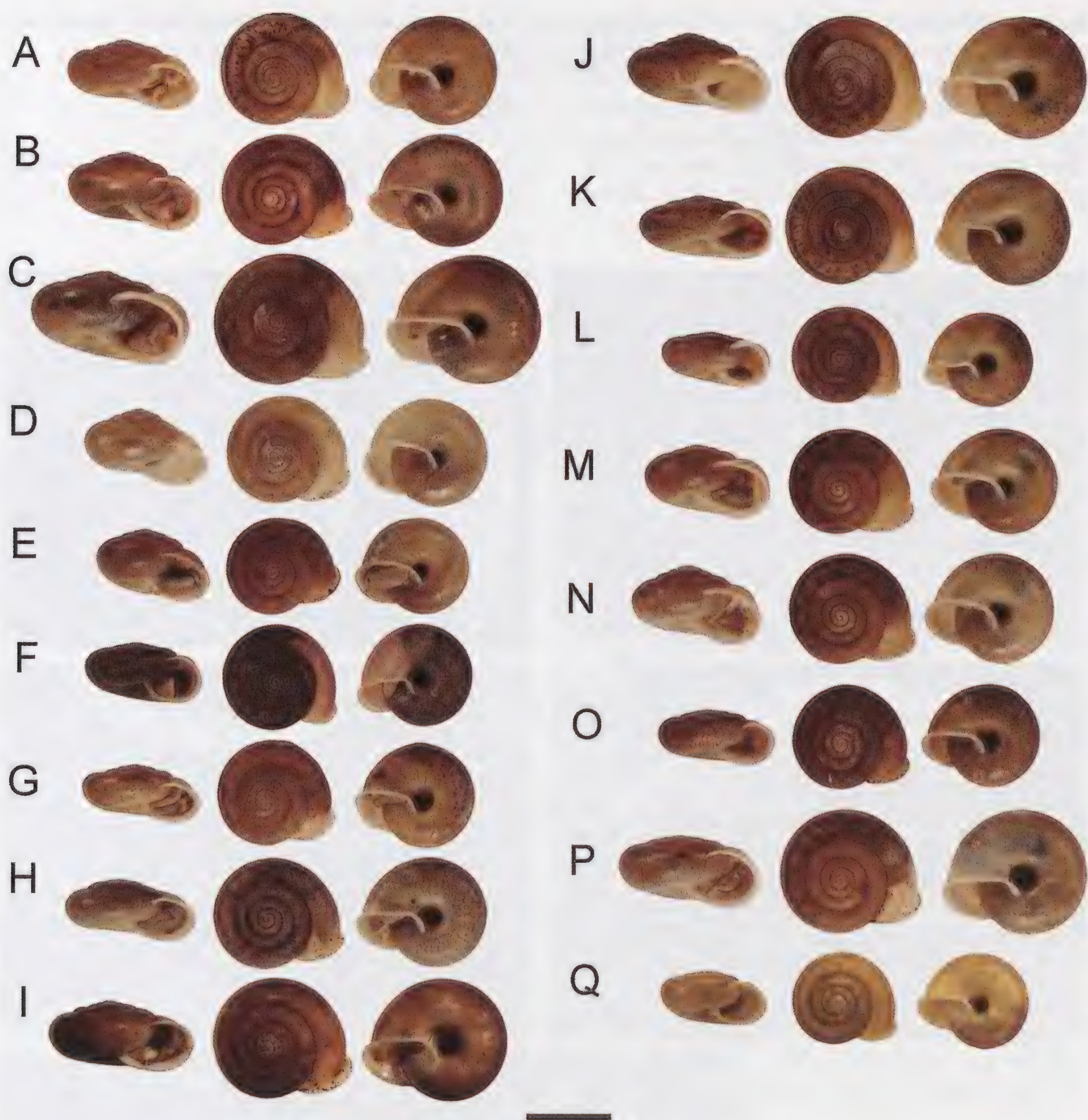


FIG. 161. Shells of *Torresitrachia* species. A: *Torresitrachia aquilonia* n. sp. holotype WAM S58451 (Sir Graham Moore Island); B: *Torresitrachia eclipsis* n. sp. holotype WAM S58452 (Long Island, Eclipse Archipelago); C: *Torresitrachia janszi* n. sp. paratype WAM S36626 (Katers Island); D: *Torresitrachia urvillei* n. sp. holotype WAM S58454 (Bigge Island); E: *Torresitrachia brookei* n. sp. holotype WAM S36735 (Boongaree Island); F: *Torresitrachia allouarni* n. sp. holotype WAM S58455 (Augustus Island, SE section); G: *Torresitrachia flindersi* n. sp. holotype WAM S58456 (Augustus Island, NW section); H: *T. flindersi* n. sp. paratype WAM S37648 (Augustus Island, NW section); I: *Torresitrachia baudini* n. sp. holotype WAM S58457 (Islet SE of Augustus Island); J: *Torresitrachia tasmani* n. sp. holotype WAM S58458 (Byam Martin Island); K: *Torresitrachia freycineti* n. sp. paratype WAM S37645 (D'Arcy Island); L: *T. freycineti* n. sp. paratype WAM S37018 (D'Arcy Island); M: *Torresitrachia houtmani houtmani* n. sp. & n. subsp. holotype WAM S58463 (unnamed island, Doubtful Bay); N: *T. houtmani dampieri* n. subsp. holotype WAM S58462 (Kingfisher Island); O: *Torresitrachia leichhardtii* n. sp. holotype WAM S58460 (Storr Island); P: *Torresitrachia hartogi* n. sp. holotype WAM S58461 (Molema Island); Q: *Torresitrachia girgarinae* n. sp. paratype WAM S37871 (Hidden Island). Scale bar = 10 mm. Note that foot produces from some shells.

epiphallic flagellum. Distal third of inner penial wall with comparatively small, densely packed, roundish pustules, proximal two thirds with indistinct longitudinal pilasters. Penial retractor muscle shorter than epiphallus. Vagina longer than free oviduct, tubular, inner wall with longitudinal pilasters. Free oviduct short, coiled.

Bursa copulatrix with inflated head, extending the anterior end of albumen gland.

Mitochondrial Differentiation

Intraspecific genetic distance (2 sequences): 0.0; interspecific genetic distances: 0.131–

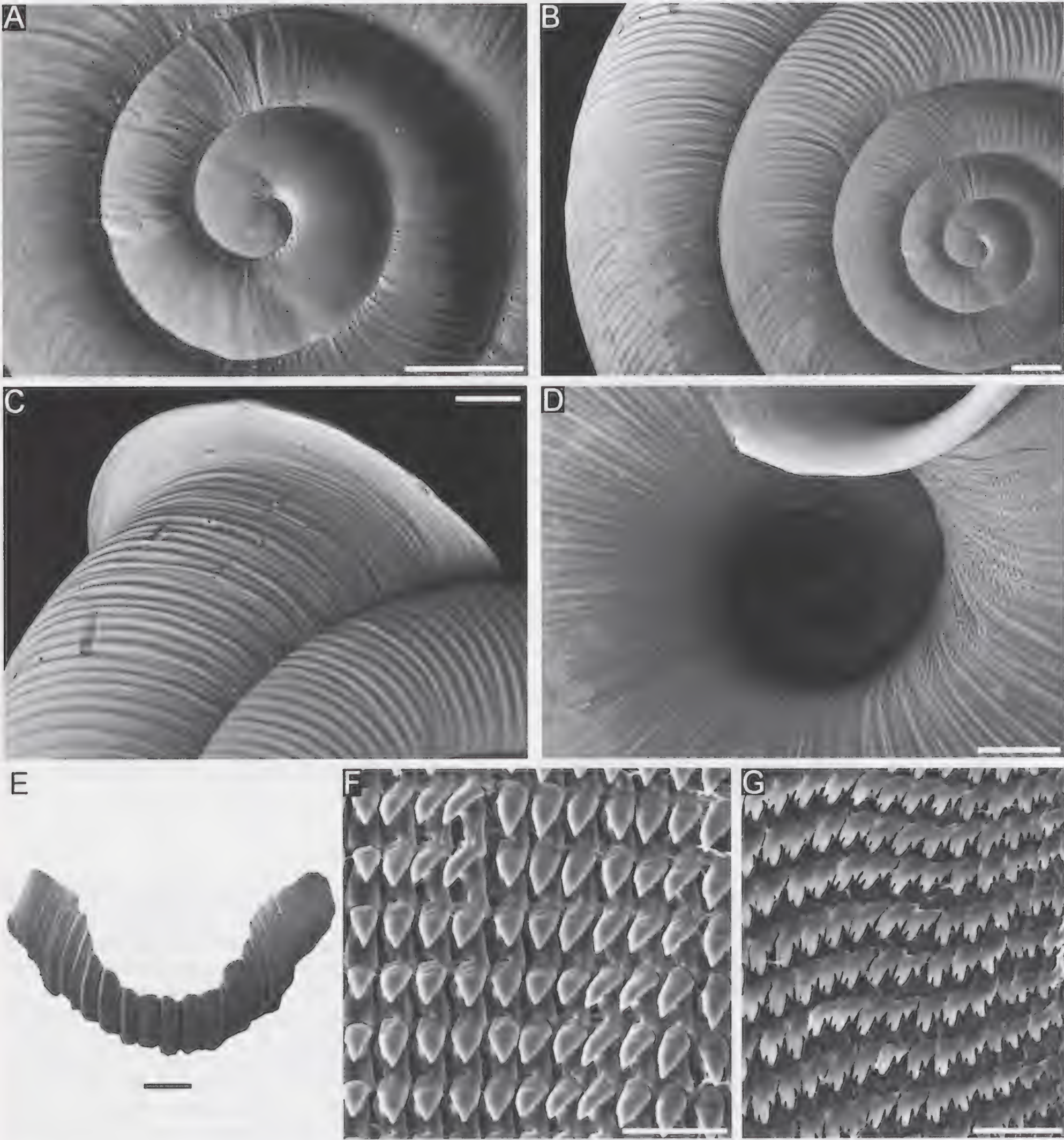


FIG. 162. SEM micrographs of *Torresitrachia aquilonia* n. sp. (Sir Graham Moore Island). A–D: Shell paratype AM C471759. Scale bars = 1 mm. A: Apical view showing protoconch and first whorl; B: Sculpture across entire shell viewed from above; C: Close-up of sculpture on last whorl near apertural lip viewed from above; D: Umbilicus; E: Jaw paratype AM C471757. Scale bar = 200 µm; F–G: Radula paratype AM C471757. Scale bars = 50 µm; F: Central and lateral teeth viewed from above; G: Middle marginal teeth viewed from above.

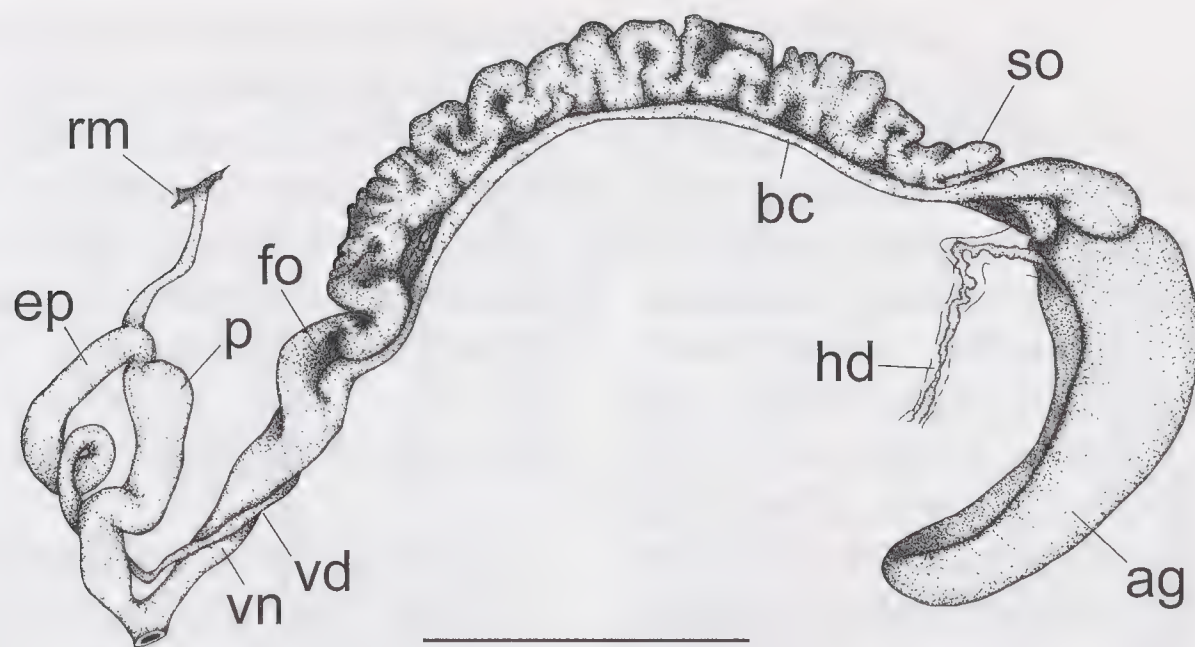


FIG. 163. Genital anatomy of *Torresitrachia aquilonia* n. sp. paratype AM C471757 (Sir Graham Moore Island, August). Scale bar = 5 mm.

0.161 with respect to *T. allouarni*, *T. baudini*, *T. flindersi*, *T. freycineti*, *T. girgarinae*, *T. hartogi*, *T. leichhardti*, and *T. tasmani*; 0.231–0.236 to all other congeners.

Comparative Remarks

Typical are an inflated head of bursa copulatrix extending the anterior end of albumen

gland and penial wall with small crowded pustules at distal third and broad but indistinct longitudinal pilasters at proximal two thirds. Penial wall sculpture of *T. brookei* is similar (see below).

Distribution (Fig. 160)

Sir Graham Moore Island.

Torresitrachia eclipsis n. sp. Figs. 161B, 165–167

Type Locality

Western Australia, northern Kimberley Vansittart Bay, Eclipse Archipelago, Long Island, 13°56'04"S, 126°18'26"E; coll. Vince Kessner, 4/06/2010, KIS 3–199 (coastal vine thicket patches on dunes and laterite; common, buried in sand).

Material Examined

Holotype WAM S58452 (preserved specimen). Paratypes WAM S49356 (preserved specimens), AM C471760 (40 shells), WAM S49348 (68 shells) from type locality.

Additional, non-type material. WAM S49347 (2 shells) from Jar Island, 14°08'59"S, 126°14'10"E.

Etymology

From "*eclipsis*" (Latin = eclipse), in reference to Eclipse Islands, where this species occurs; noun in apposition.

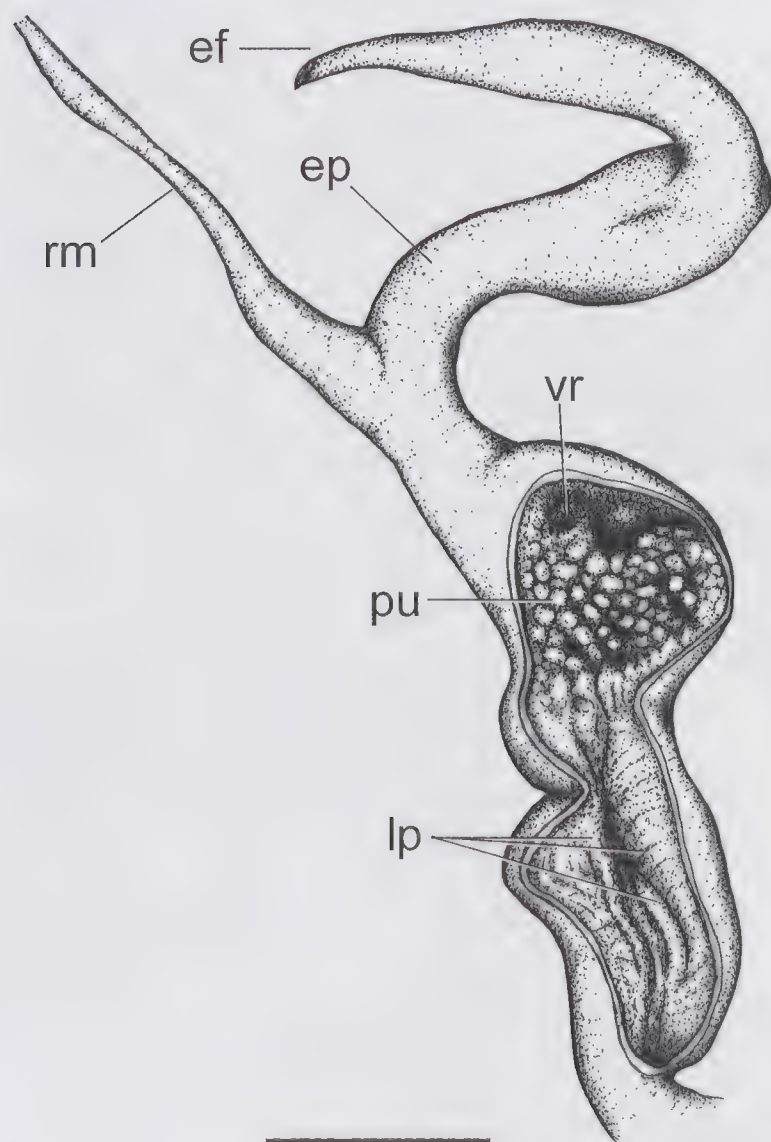


FIG. 164. Penial anatomy of *Torresitrachia aquilonia* n. sp. paratype AM C471757 (Sir Graham Moore Island, August). Scale bar = 1 mm.

Description

Shell (Figs. 161B, 165): Moderate in size ($D = 13.0\text{--}16.5\text{ mm}$; Table 10), very broadly conical with moderately elevated spire; periphery well rounded to slightly depressed; umbilicus $\sim 2.3\text{ mm}$ wide; glossy surface. Protoconch $\sim 2.3\text{ mm}$ in diameter, comprising about one whorl, essentially smooth. Teleoconch with regularly and narrowly spaced radial ribs; inner umbilical whorls with microsculpture of fine periostracal extensions. Apertural lip sharp, weakly expanded, slightly reflected, well rounded without nodes, parietal wall extremely delicate.

Genital anatomy (Figs. 166–167): Penis as long as vagina, straight. Epiphallus coiled, clearly shorter than penis, with moderately long epiphallic flagellum. Distal three quarters of inner penial wall with large, rhomboid pustules, densely arranged in honeycomb pattern; pad-like elevated underneath opening to epiphallus;

proximal end with five to six short, well-defined longitudinal pilasters. Inner epiphallic wall with longitudinal pilasters. Penial retractor muscle short. Vagina longer than free oviduct, slightly inflated. Free oviduct short, coiled. Bursa copulatrix with slightly inflated head, barely reaching anterior end of albumen gland.

Mitochondrial Differentiation

Interspecific genetic distances (1 sequence): 0.143–0.160 with respect to *T. brookei*, *T. urvillei*, *T. dampieri*, and *T. janszi*; 0.194–0.226 to all other congeners.

Comparative Remarks

Shell more elevated than in *T. aquilonia*, with narrower umbilicus, last whorl slightly depressed rather than slightly shouldered above periphery, apertural lip not as strongly expanded, surface not as glossy. Penial wall

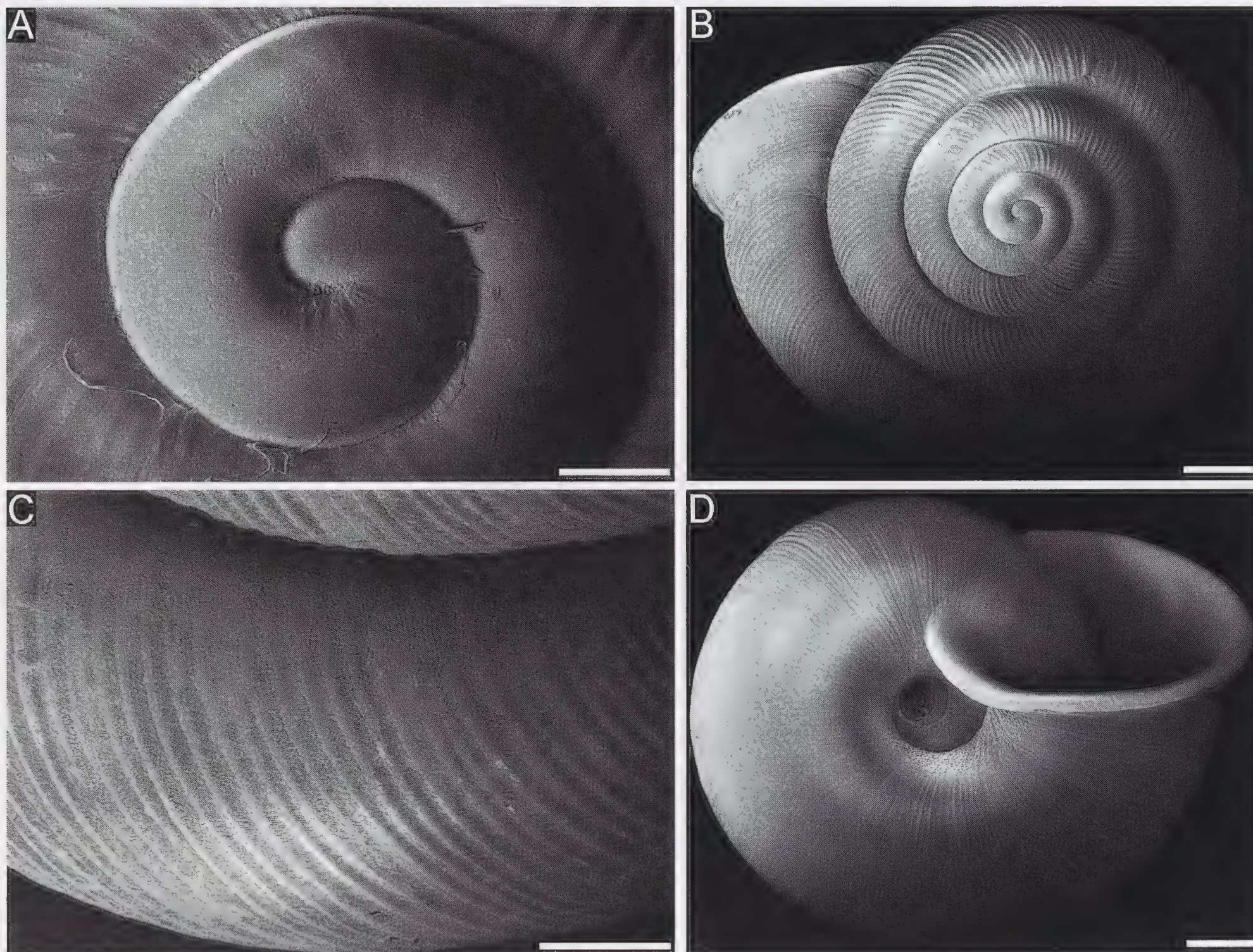


FIG. 165. SEM micrographs of the shell of *Torresitrachia eclipsis* n. sp. paratype AM C471760 (Long Island, Vansittart Bay). A: Apical view showing protoconch. Scale bar = 500 μm ; B: Sculpture across entire shell viewed from above. Scale bar = 2 mm; C: Close-up of sculpture on last whorl viewed from above. Scale bar = 1 mm; D: Shell viewed from below showing umbilicus and aperture. Scale bar = 2 mm.

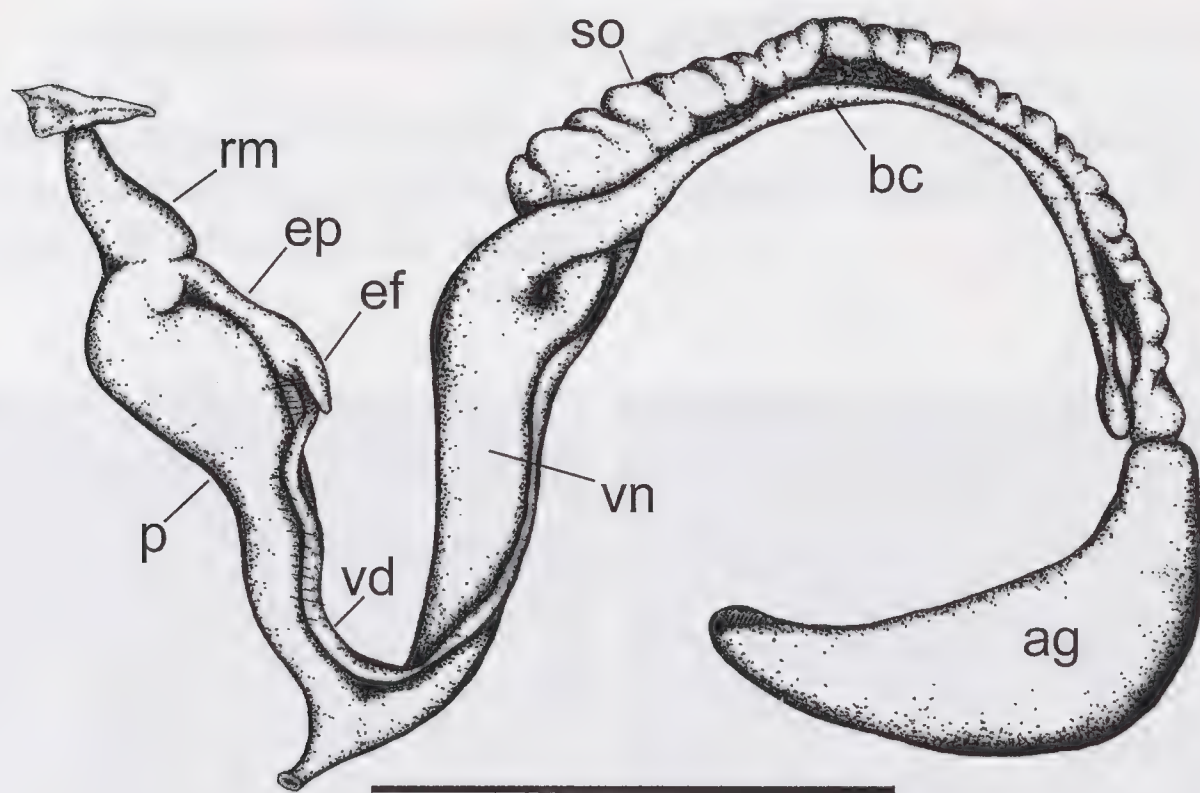


FIG. 166. Genital anatomy of *Torresitrachia eclipsis* n. sp. paratype WAM S49346 (Long Island, Vansittart Bay, June). Scale bar = 5 mm.

sculpture is typical for this species; only *T. janszi* being similar (see below).

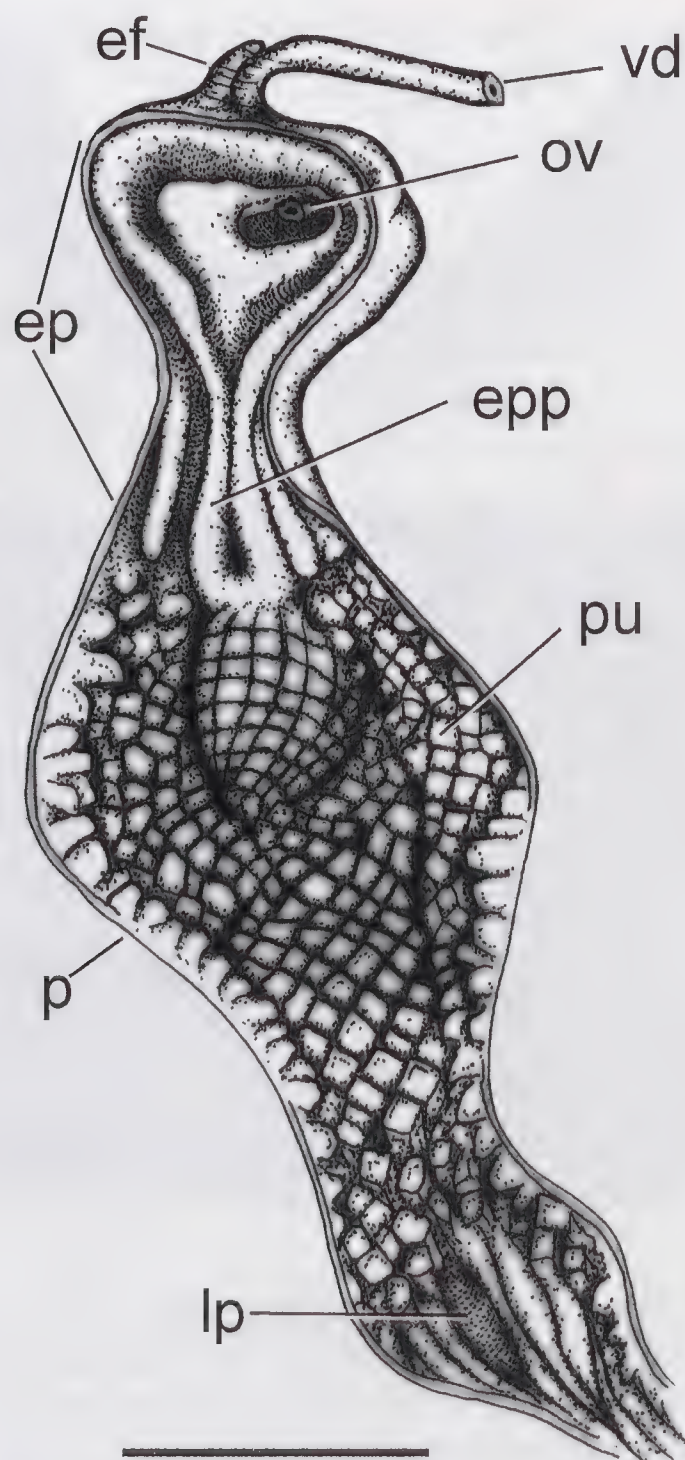


FIG. 167. Penial anatomy of *Torresitrachia eclipsis* n. sp. paratype WAM S49346 (Long Island, Vansittart Bay, June). Scale bar = 1 mm.

Distribution (Fig. 160)

Long and Jar islands, Vansittart Bay, Eclipse Archipelago.

Torresitrachia amaxensis
Solem, 1979

Torresitrachia amaxensis Solem, 1979: 79–84, pls 4e–f, 5g–l, figs. 15a–c, 16a, b; 1985a: 923, 1991: 181.

Type Locality

Camp Creek, Mitchell Plateau.

Taxonomic Remarks

The name was introduced for specimens from several localities in the Mitchell Plateau. Solem (1985a) reported shells from Bigge Island, while Solem (1991) stated that affinities of specimens from Katers and Bigge Island remain doubtful. During the Kimberley Survey this species was not found on these islands but yet undescribed species were found. *Torresitrachia amaxensis* is probably restricted to the Mitchell Plateau and is unlikely to occur on off-shore islands.

Diagnosis

Shell: Comparatively large ($D = 18\text{--}20\text{ mm}$), broadly conical with elevated spire; umbilicus $\sim 1.5\text{ mm}$ wide. Regularly and narrowly spaced radial ribs nearly absent from base of shell.

Genital anatomy: Penis comparatively large in size, with inflated posterior portion. Distal

half of inner penial wall with crowded, rhomboid pustules with hooked tip, proximal portion with well-developed longitudinal pilasters. Inner epiphallic wall with thick longitudinal pilasters (after Solem, 1979).

Comparative Remarks

Typical features of penial wall sculpture are crowded, large, rhomboid, hooked pustules at distal half of interior wall and crowded, strongly

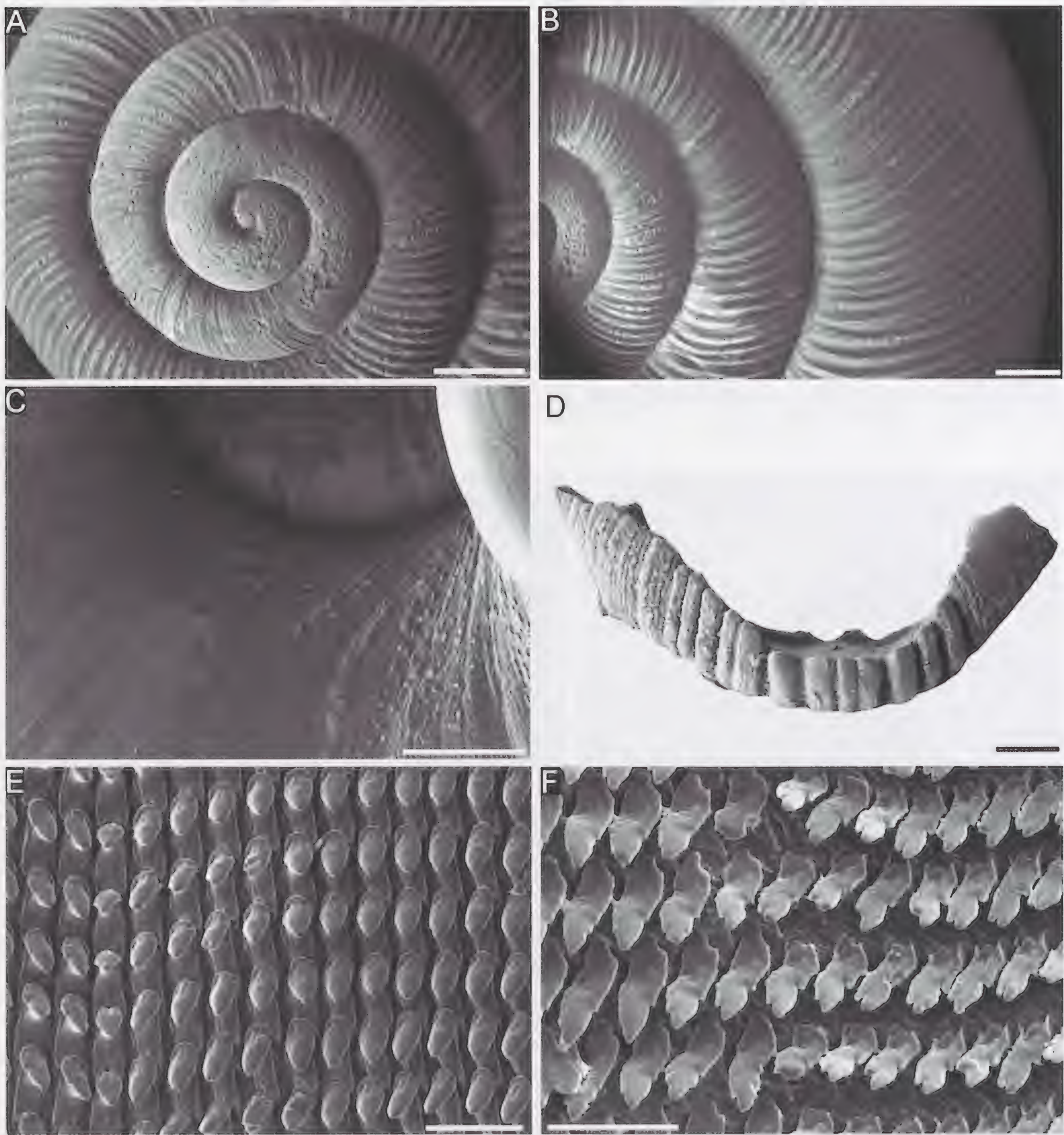


FIG. 168. SEM micrographs of *Torresitrachia janszi* n. sp. (Katers Island). A–C: Shell paratype AM C471762. Scale bars = 1 mm. A: Apical view showing protoconch and first whorl; B: Sculpture across entire shell viewed from above; C: Close-up of inner umbilical whorls showing periostracal granules; D: Jaw holotype WAM S58453. Scale bar = 200 μ m; E–F: Radula holotype WAM S58453. Scale bars = 50 μ m; E: Central and lateral teeth viewed from above; F: Transitional and middle marginal teeth viewed from above.

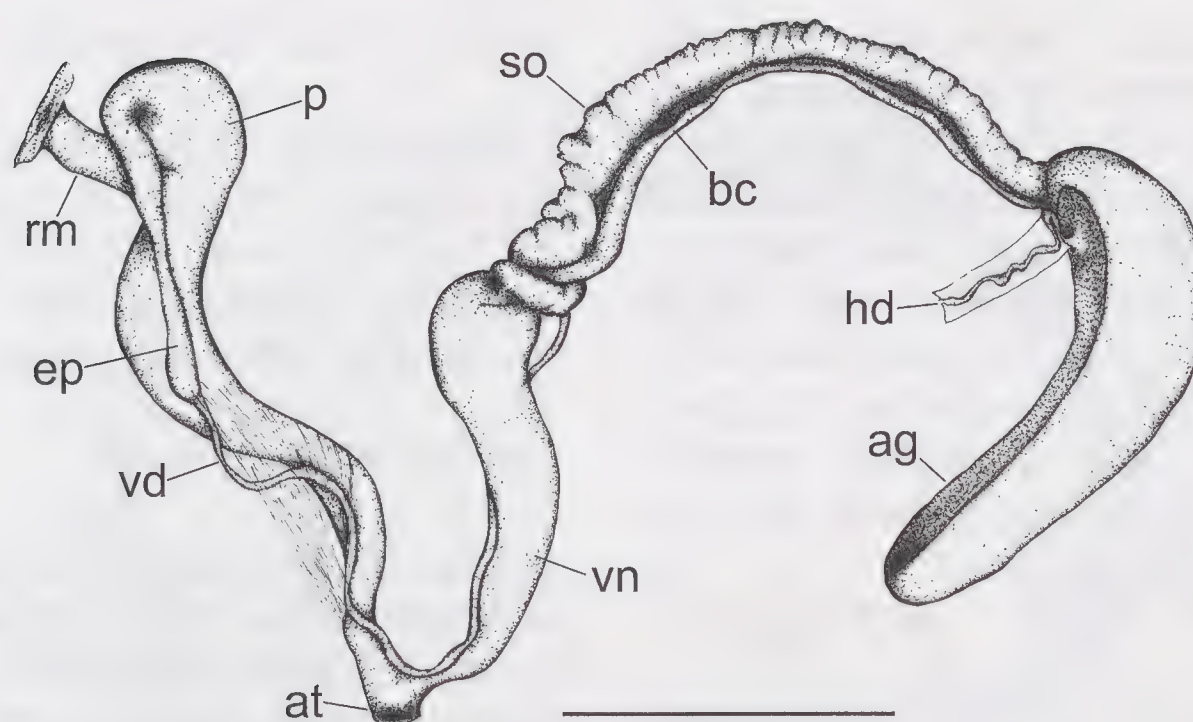


FIG. 169. Genital anatomy of *Torresitrachia janszi* n. sp. holotype WAM S58453 (Katers Island, July). Scale bar = 3 mm.

developed longitudinal pilasters at proximal half, inflated distal proper of penis, comparatively short, inflated epiphallus. *Torresitrachia aquilonia* has fewer, smaller and roundish pustules and more indistinct pilasters.

***Torresitrachia janszi* n. sp.**

Figs. 161C, 168–170

Type Locality

Western Australia, northwestern Kimberley, Bonaparte Archipelago, Montague Sound, W section of Katers Island, 14°26'51.0"S, 125°30'51.7"E; coll. Roy Teale, 30/07/2007, KIS 2–6 (N-facing slope in woodland/vine thicket, dolerite derived soils, sandstone scree; under logs and rocks).

Material Examined

Holotype WAM S58453 (preserved specimen, dissected). Paratypes WAM S36628 (4 preserved specimens) from type locality; WAM S36626 (preserved specimen) from 14°26'51.6"S, 125°31'07.1"E; WAM S36627 (2 preserved specimens), WAM S36418 (shell) from 14°26'57.5"S, 125°31'08.7"E; WAM S36629 (preserved specimen), WAM S36419 (shell) from 14°26'45.6"S, 125°31'16.1"E; WAM S36420 (shell) from 14°26'32.4"S, 125°31'14.4"E; WAM S36870 (5 preserved specimens) from 14°26'52"S, 125°31'13"E; AM C471761 (2 preserved specimens), WAM S36871 (5 preserved specimens), AM C471762 (2 shells), WAM S36965 (4 shells) from 14°26'49"S, 125°31'15"E.

Etymology

In honour of Willem Jansz, the first European explorer to make authenticated discovery of Australia when in command of the *Duyfken* in 1606; noun in genitive case.

Description

Shell (Figs. 161C, 168A–C): Large ($D = 17.8\text{--}19.5$ mm; Table 10), broadly conical with moderately elevated spire; umbilicus ~ 3 mm

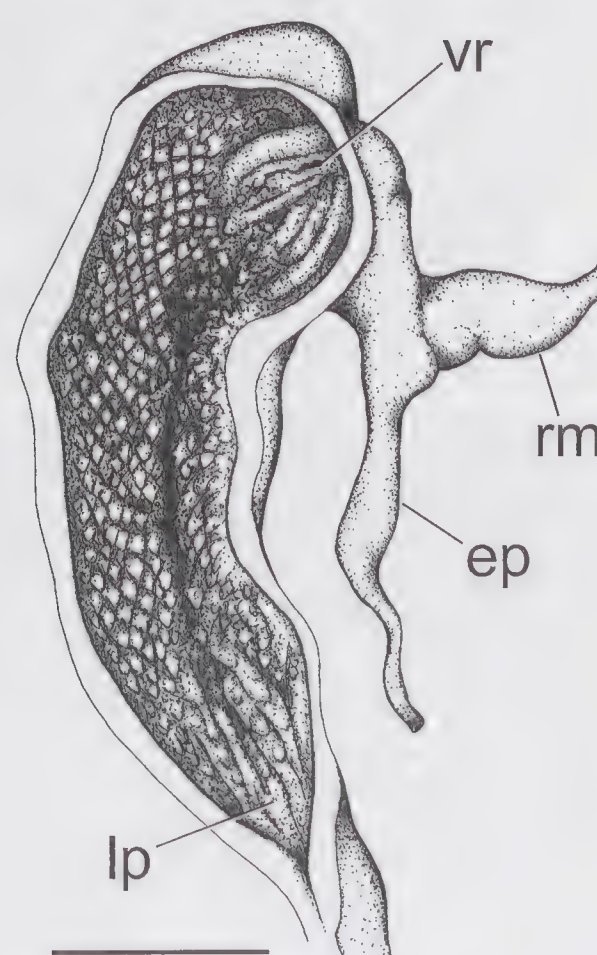


FIG. 170. Penial anatomy of *Torresitrachia janszi* n. sp. holotype WAM S58453 (Katers Island, July). Scale bar = 2 mm.

wide; colour horn, glossy. Protoconch ~ 2.3 mm in diameter, comprising about 1.5 whorls, essentially smooth with erosion scars. Teleoconch with fine, regularly and narrowly spaced radial ribs, becoming indistinct below periphery and extending as weak growth lines onto base of shell; inner umbilical whorls sculptured with microsculpture of fine periostracal pustules. Apertural lip sharp, well expanded, weakly reflected, well rounded without nodes, parietal wall extremely delicate.

Radula (Fig. 168D–F): C + 20 + 2–3 + ? (n = 1).

Genital anatomy (Figs. 169–170): Penis longer than vagina, straight. Epiphallus clearly shorter than penis, with tiny epiphallic flagellum. Distal three quarters of inner penial wall with small, rhomboid pustules, densely arranged in honeycomb pattern; proximal end with five to six short, well-defined longitudinal pilasters. Inner epiphallic wall with longitudinal pilasters. Penial retractor muscle short. Vagina longer than free oviduct, inflated. Free oviduct very short, coiled. Bursa copulatrix with slightly inflated head, reaching anterior end of albumen gland.

Mitochondrial Differentiation

Intraspecific genetic distance (3 sequences): 0.0–0.003; interspecific genetic distances: 0.136–0.157 with respect to *T. brookei*, *T. dampieri*, *T. eclipsis*, and *T. urvillei*; 0.211 to 0.236 to all other congeners.

Comparative Remarks

Shell larger than that of *T. aquilonia* and *T. eclipsis*; unlike in the former two species ribs on shell do not extend into umbilicus. Typical feature of penial wall sculpture is presence of small, rhomboid pustules, densely arranged in honeycomb pattern comprising almost entire length of wall. *Torresitrachia eclipsis* differs by having larger pustules and much shorter penis relative to length of vagina. Number of lateral teeth of radula larger than in *T. aquilonia*.

Distribution (Fig. 160)

Katers Island.

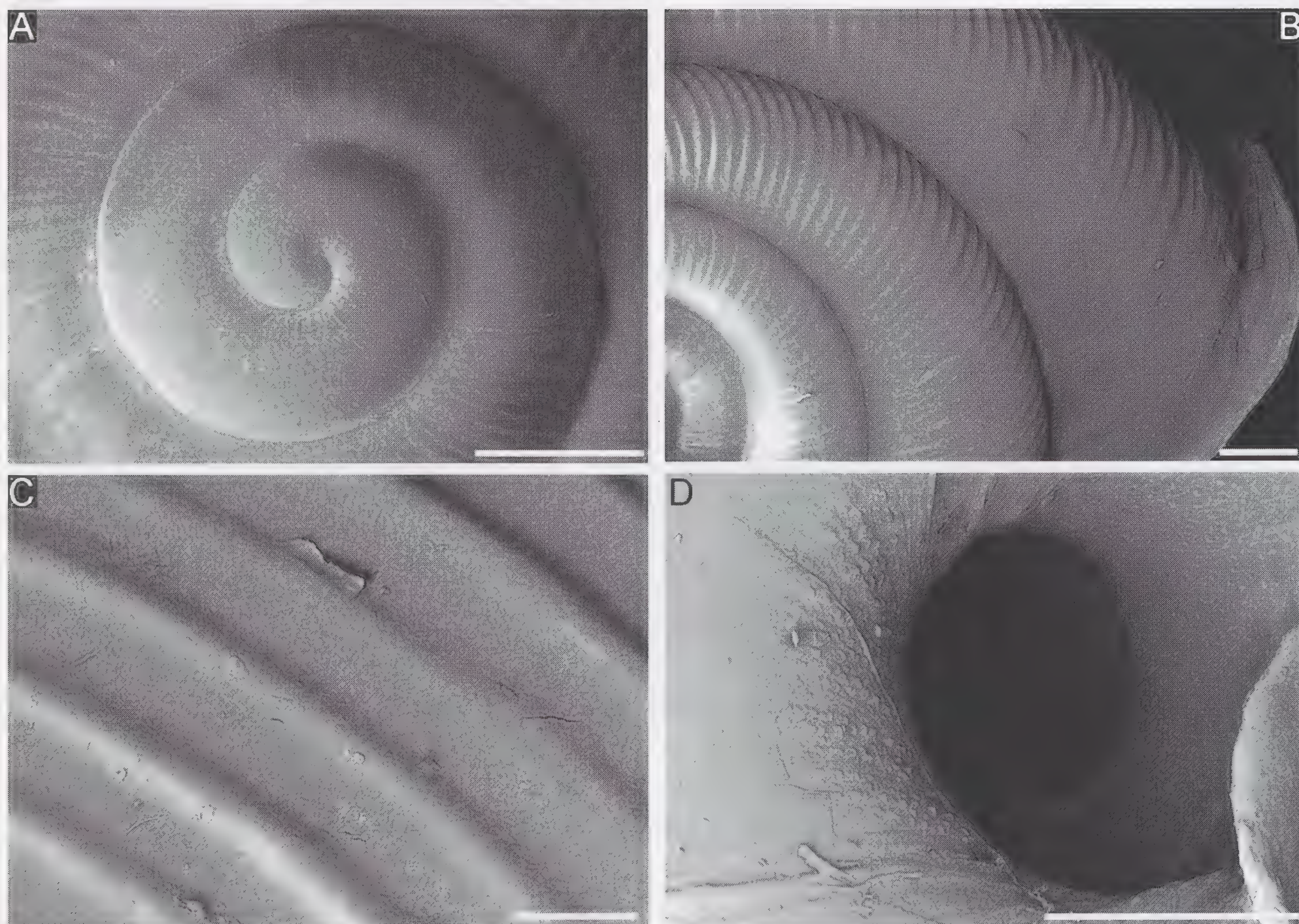


FIG. 171. SEM micrographs of the shell of *Torresitrachia urvillei* n. sp. paratype AM C471764 (Bigge Island). A: Apical view showing protoconch and first whorl; B: Sculpture across entire shell viewed from above; C: Close-up of sculpture on last whorl; D: Umbilicus. Scale bars A–B, D = 1 mm, C = 200 μ m.

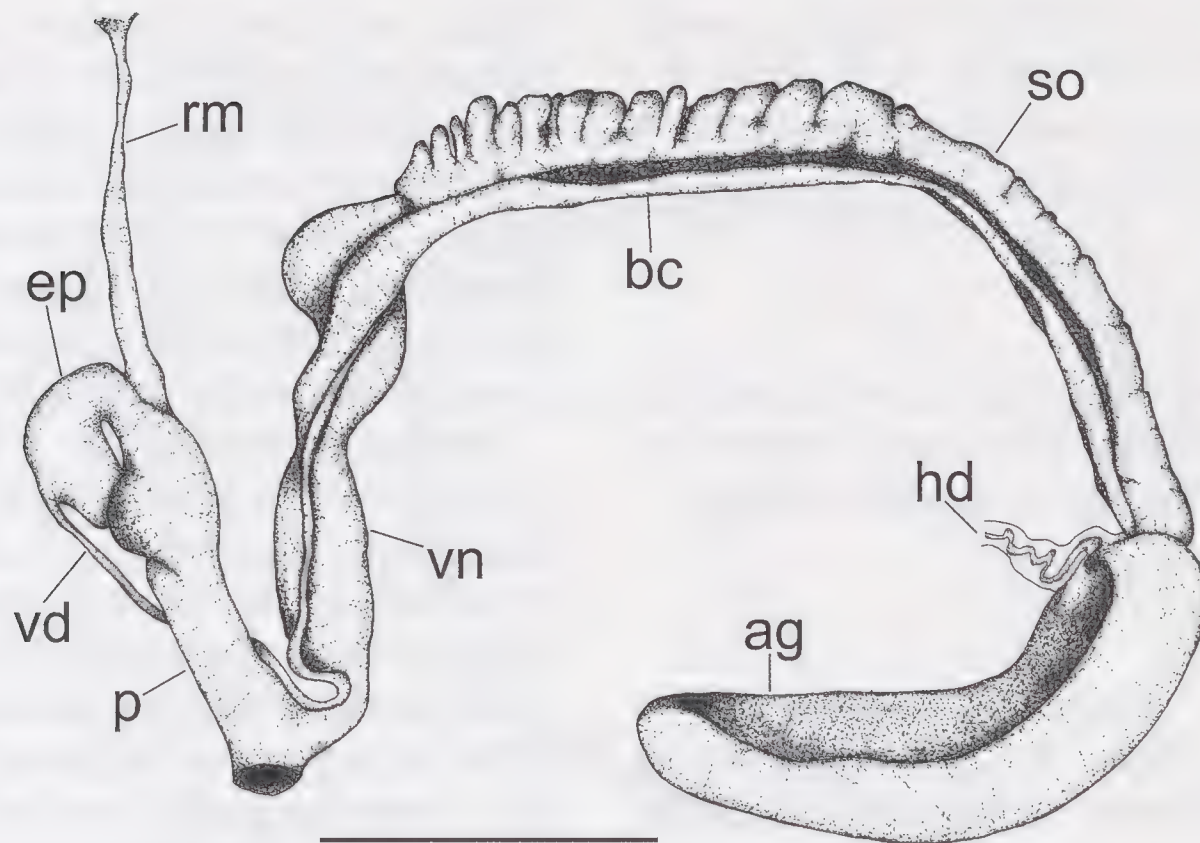


FIG. 172. Genital anatomy of *Torresitrachia urvillei* n. sp. paratype AM C471763 (Bigge Island, July). Scale bar = 3 mm.

Torresitrachia urvillei n. sp.
Figs. 161D, 171–173

125°06'08"E; WAM S36733 (6 preserved specimens), WAM S36731 (2 shells) from 14°35'06"S,

Type Locality

Western Australia, northwestern Kimberley, Bonaparte Archipelago, Bigge Island, 4.16 km NNE of Savage Hill, 14°35'19"S, 125°11'08"E; coll. Michael Shea, 29/07/2007, KIS 1–9 (dry vine thicket on creek floodplain; in rotting *Pandanus* logs).

Material Examined

Holotype WAM S58454 (preserved specimen, Fig. 161D). Paratypes AM C471763 (7 preserved specimens), WAM S36649 (11 preserved specimens), WAM S36427 (2 shells) from type locality; AM C471764 (5 shells), WAM S36421 (10 shells) from 14°35'20"S, 125°11'07"E; WAM S36730 (5 preserved specimens), WAM S36422 (2 shells) from 14°35'27"S, 125°11'03"E; WAM S36423 (shell) from 14°35'16"S, 125°11'06"E; WAM S36731 (3 preserved specimens), WAM S36424 (5 shells) from 14°35'33"S, 125°11'19"E; WAM S36425 (13 shells) from 14°35'14"S, 125°11'08"E; WAM S36426 (2 shells) from 14°35'14"S, 125°10'53"E; WAM S36428 (2 shells) from 14°35'10"S, 125°11'06"E; WAM S36429 (2 shells) from 14°34'35"S, 125°05'57"E; WAM S36430 (3 shells) from 14°35'06"S, 125°06'12"E; WAM S36453 (2 shells) from 14°35'16"S, 125°11'02"E; AM C471765 (6 shells), WAM S36453 (10 shells) from 14°34'59"S, 125°06'22"E; WAM S36732 (6 preserved specimens) from 14°35'06"S,

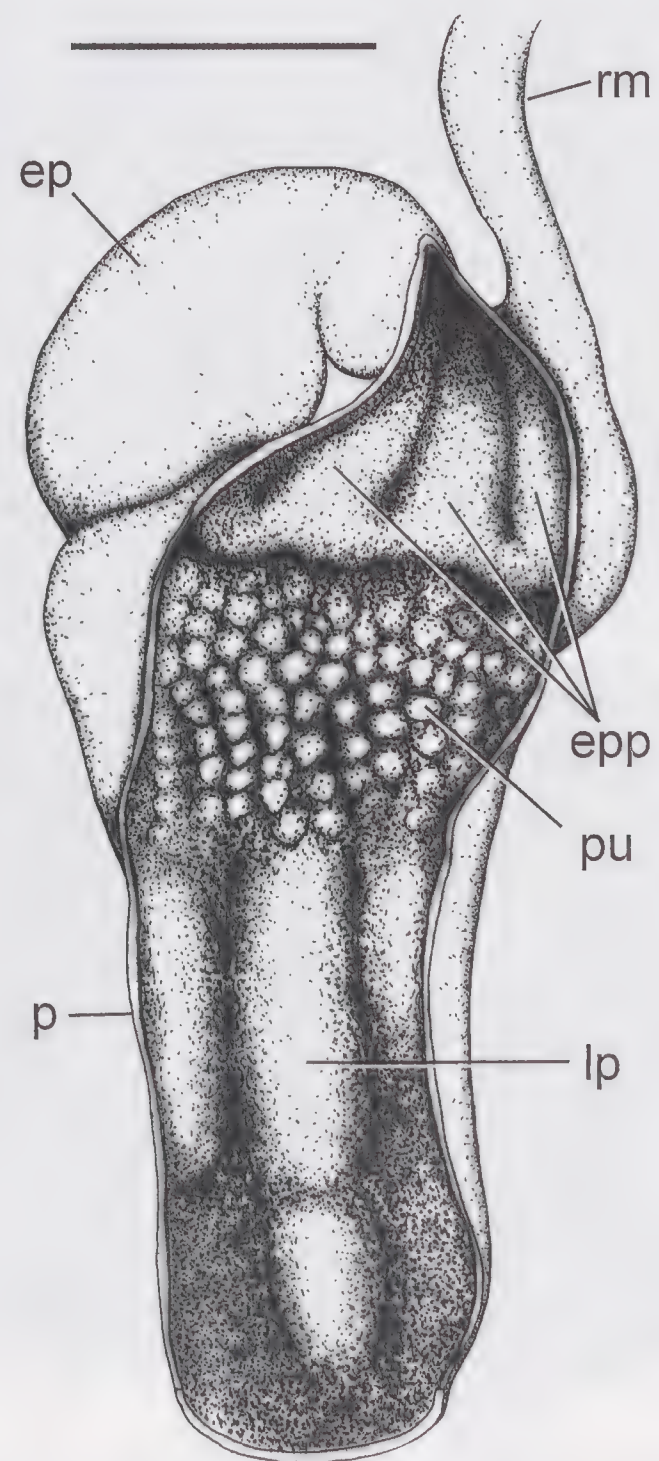


FIG. 173. Penial anatomy of *Torresitrachia urvillei* n. sp. paratype AM C471763 (Bigge Island, July). Scale bar = 1 mm.

125°06'12"E; WAM S36897 (3 preserved specimens) from 14°35'15"S, 125°11'05"E; WAM S36902 (4 preserved specimens) from 14°35'18.5"S, 125°10'54.7"E.

Etymology

In honour of Jules Dumont d'Urville, who in 1826 led an expedition to Western Australia on board the *Astrolabe*; noun in genitive case.

Description

Shell (Figs. 161D, 171): Moderate in size ($D = 12.7\text{--}17.6$ mm; Table 10), broadly conical with moderately elevated spire; periphery well rounded to slightly depressed, whorls separated by rather shallow suture; umbilicus ~ 2.2 mm wide; colour brownish horn, not glossy. Protoconch ~ 2.3 mm in diameter, comprising about one whorl, essentially smooth. Teleo-

conch with fine, regularly spaced radial ribs, becoming more indistinct below periphery and extending as weak growth lines onto base of shell; inner umbilical whorls sculptured with microsculpture of fine periostracal pustules. Apertural lip sharp, rather weakly expanded and reflected, well rounded without nodes, parietal wall extremely delicate.

Genital anatomy (Figs. 172–173): Penis moderately shorter than vagina, straight. Epiphallus shorter than penis, with small epiphallic flagellum. Distal third of inner penial wall with small, roundish pustules, densely arranged in honeycomb pattern; proximal two thirds with three broad, rather indistinct longitudinal pilasters. Inner epiphallic wall with four longitudinal pilasters. Penial retractor muscle longer than penis. Vagina longer than free oviduct, inflated. Free oviduct very short, coiled. Bursa copulatrix with slightly inflated head, reaching anterior end of albumen gland.

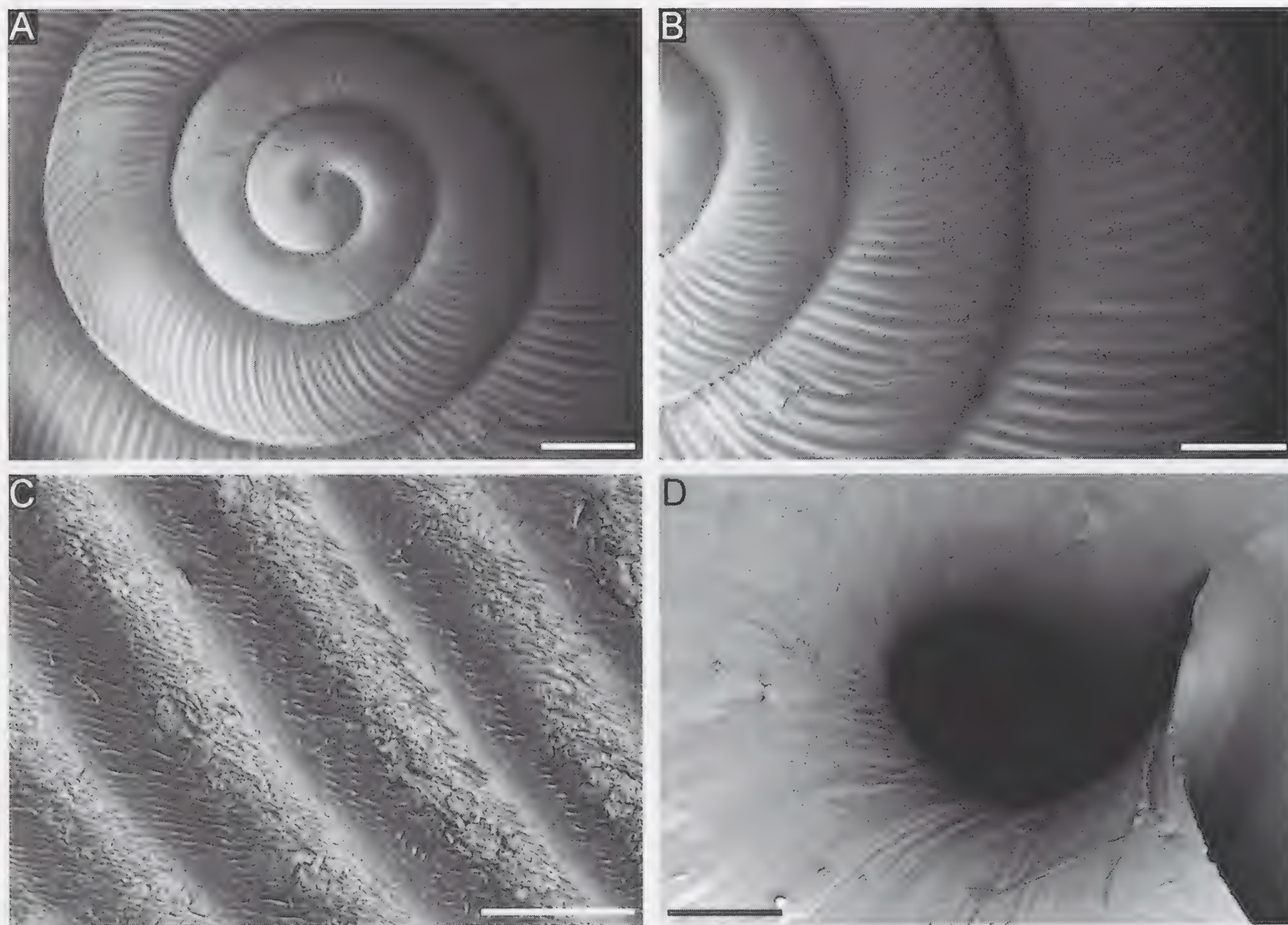


FIG. 174. SEM micrographs of the shell of *Torresitrachia brookei* n. sp. paratype AM C471769 (Boongaree Island). A: Apical view showing protoconch and first whorls; B: Sculpture across entire shell viewed from above. Scale bars A–B = 1 mm; C: Close-up of sculpture on last whorl. Scale bar = 200 μm ; D: Umbilicus. Scale bar = 500 μm .

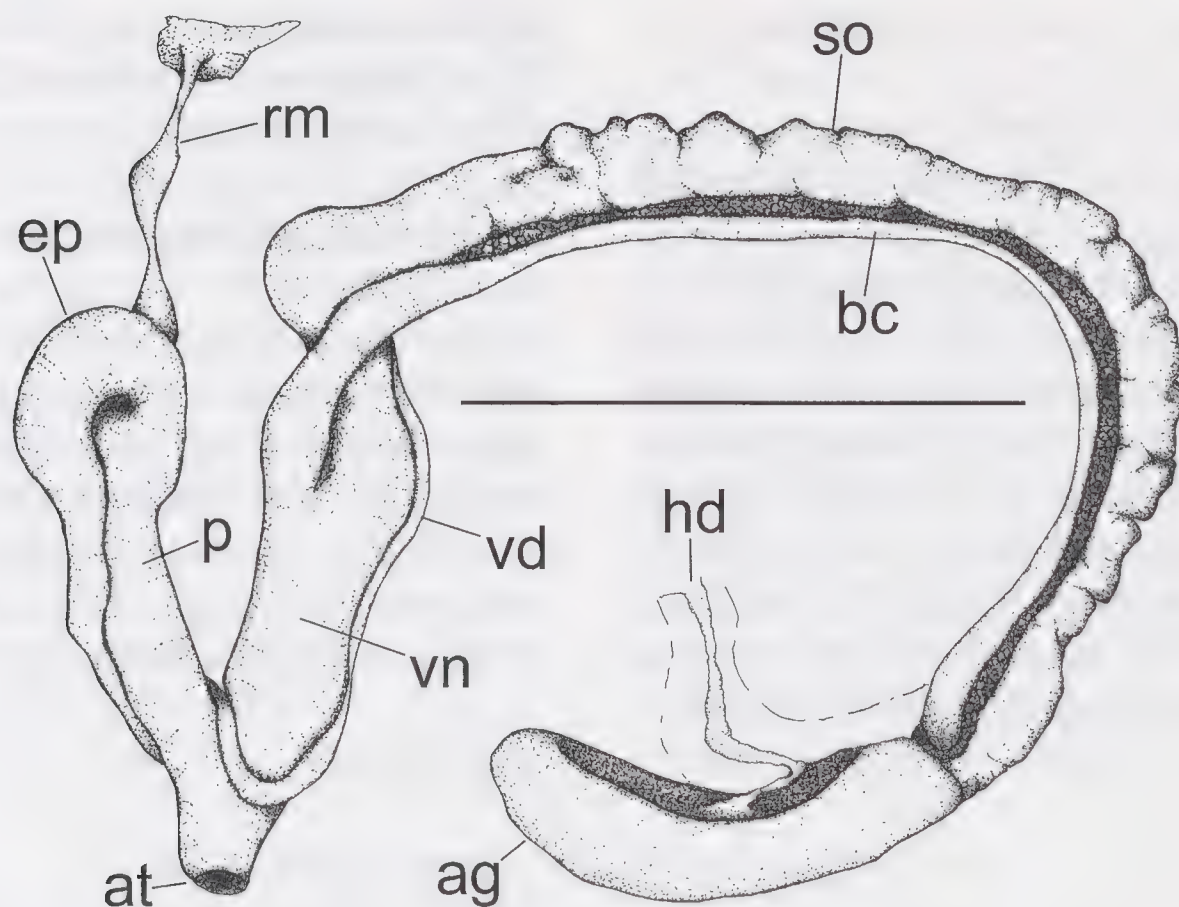


FIG. 175. Genital anatomy of *Torresitrachia brookei* n. sp. paratype AM C471766 (Boongaree Island, August). Scale bar = 3 mm.

Mitochondrial Differentiation

Intraspecific genetic distance (3 sequences): 0.0–0.001; interspecific genetic distances: 0.095–0.142 with respect to *T. brookei*, *T. houtmani*, *T. eclipsis* and *T. janszi*; 0.206 to 0.237 to all other congeners.

Comparative Remarks

Species was listed by Solem (1991) as "*Torresitrachia* NSP2". Shell smaller than that of *T. janszi*, differs from *T. aquilonia* and *T. eclipsis* by lack of ribs within the umbilicus; lip more weakly expanded than in *T. aquilonia*. Penial morphology similar to *T. amaxensis* and *T. aquilonia* with respect to distribution of pustules and pilasters (*T. amaxensis* with larger, hooked pustules and stronger pilasters, *T. aquilonia* with not as regularly arranged pustules, weaker pilasters).

Distribution

Bigge Island.

Torresitrachia brookei n. sp.
Figs. 161E, 174–176

Type Locality

Western Australia, northwestern Kimberley, Bonaparte Archipelago, central section of

Boongaree Island, 15°04'14"S, 125°10'58"E; coll. Michael Shea, 8/08/2007, KIS 1–29 (dry woodland with mixed deciduous trees and shrubs; aestivating in soil between rocks).

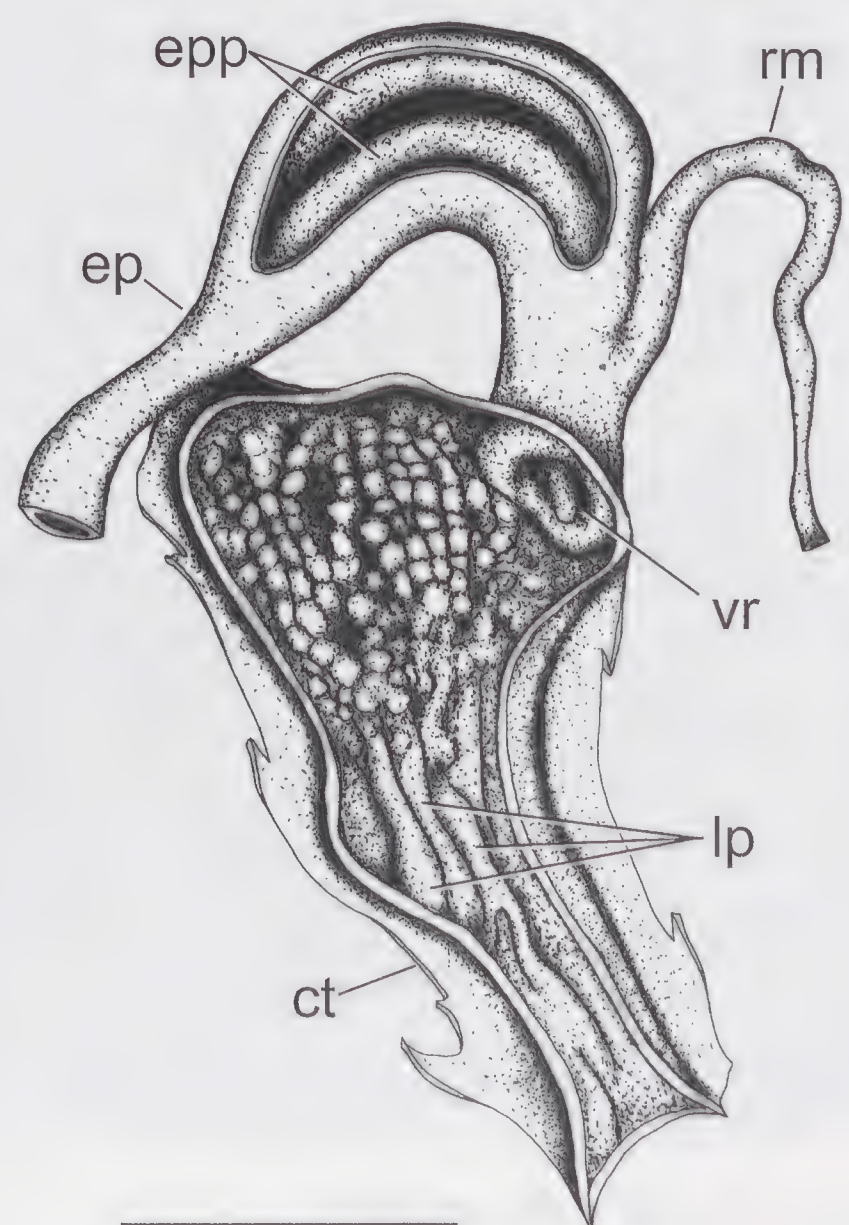


FIG. 176. Penial anatomy of *Torresitrachia brookei* n. sp. paratype AM C471766 (Boongaree Island, August). Scale bar = 1 mm.

Material Examined

Holotype WAM S36735 (preserved specimen, Fig. 161E). Paratypes AM C471766 (3 preserved specimens), WAM S36734 (10 preserved specimens), AM C471767 (3 shells), WAM S36432 (7 shells) from 15°04'21"S, 125°11'06"E; AM C471768 (3 shells), WAM S36433 (6 shells) from 15°04'26"S, 125°10'46"E; WAM S36434 (2 shells) from 15°04'22"S, 125°10'56"E; WAM S36435 (2 shells) from 15°04'08"S, 125°11'05"E; AM C471769 (3 shells), WAM S36436 (4 shells) from 15°04'09"S, 125°10'49"E; WAM S37647 (2 preserved specimens) 15°04'30"S, 125°11'21"E.

Etymology

In honour of John Brooke, amongst the first Englishman to arrive in Australia on board of the *Trial*, which was wrecked in May 1622 in northwestern Australia; noun in genitive case.

Description

Shell (Figs. 161E, 174): Moderate in size ($D = 12.2\text{--}17.3$ mm; Table 10), broadly conical with weakly to moderately elevated spire; umbilicus ~ 2 mm wide; colour brownish, not glossy. Protoconch ~ 2.0 mm in diameter, comprising about one whorl, essentially smooth. Teleoconch with very fine, regularly and narrowly spaced radial ribs, becoming indistinct below periphery and extending as weak growth lines onto base of shell; inner umbilical whorls with sparsely covered with fine periostracal pustules. Apertural lip sharp, rather weakly expanded and reflected, well rounded without nodes, parietal wall extremely delicate.

Genital anatomy (Figs. 175–176): Penis about as long as vagina, straight. Epiphallus about same length, with tiny epiphallic flagellum. Distal half of inner penial wall with small, roundish pustules, loosely arranged in rather irregular pattern; proximal half with indistinct longitudinal pilasters. Inner epiphallic wall with two large longitudinal pilasters. Penial retractor muscle moderately long. Vagina longer than free oviduct, inflated. Free oviduct short, S-shaped. Bursa copulatrix with slightly inflated head, reaching anterior end of albumen gland.

Mitochondrial Differentiation

Intraspecific genetic distance (2 sequences): 0.001; interspecific genetic distances: 0.107–

0.157 with respect to *T. brookei*, *T. dampieri*, *T. eclipsis* and *T. janszi*; 0.203 to 0.236 to all other congeners.

Comparative Remarks

Shell most similar with *T. urvillei* and *T. eclipsis*. Umbilicus narrower than in *T. eclipsis*, which also has a glossy shell. Penial anatomy similar to *T. urvillei*, *T. amaxensis* and *T. aquilonia* but differing in relative size, shape and arrangement of pustules and development of longitudinal pilasters.

Distribution

Boongaree Island.

Torresitrachia bathurstensis
(E. A. Smith, 1894)

Helix (*Trachia*) *bathurstensis* E. A. Smith, 1894: 93.

Torresitrachia bathurstensis – Solem, 1979: 67–71 (partim); 1985a: 922–923 (partim); 1991: 178–179 (partim).

Type Locality

Bathurst Island, as restricted by Solem (1979).

Taxonomic Remarks

The name was originally introduced for specimens from Bathurst and Heywood islands but the type locality was subsequently restricted to Bathurst Island by Solem (1979). Solem (1979) based his anatomical description on material from the Kimbolton area (~ 16°41'12"S, 123°50'13"E), on the mainland about 80 km south of Bathurst Island, assuming that both forms were conspecific. Predominantly (or even exclusively?) based on comparison of shells, Solem (1979, 1985a, 1991) assumed that this species occupies a wide range to include mainland sites up north to Doubtful Bay as well as many islands in the Buccaneer Archipelago north to Augustus Island. However, comparative study of island forms that Solem (1991) had or would have subsumed under this taxon indicated that *T. bathurstensis* represents a complex of species of which most are narrowly endemic to single islands or even portions of larger islands. While these species exhibit relatively conserved shell characters, they differ

predominantly in their genital anatomy. While several island forms are herein recognised as distinct species, I suggest restricting the taxon *T. bathurstensis* to its type locality, Bathurst Island, and possibly immediately adjacent localities. The material from the Kimbolton area used to describe the anatomy of this taxon is likely to represent yet another distinct species but not *T. bathurstensis* as delineated herein. For the uncertain delimitation of the taxon, no diagnosis is given here.

***Torresitrachia allouarni* n. sp.**
Figs. 161F, 177–179

Type Locality

Western Australia, central Kimberley coast, Brecknock Harbour, SE corner of Augustus Island, 15°23'45"S, 124°37'47"E; coll. Vince Kessner, 12/02/2009, KIS 2–71 (vine thicket patch along creek line, on steep rocky slopes

in V-shaped gully, sandstone; active on ground and boulders at night after rain).

Material Examined

Holotype. WAM S58455 (preserved specimen, Fig. 161F). Paratypes AM C471770 (4 preserved specimens), WAM S37655 (9 preserved specimens), AM C471771 (2 shells), WAM S49009 (3 shells) from type locality.

Additional, non-type material. WAM S37010 (preserved specimens) from southern section of Augustus Island, 15°23'53"S, 124°36'03"E, WAM S37011 (preserved specimens) from 15°24'02"S, 124°36'06"E.

Etymology

In honour of François-Alesno de St. Allouarn, the first French explorer to arrive in Western Australia in March 1772, near Shark Bay; noun in genitive case.

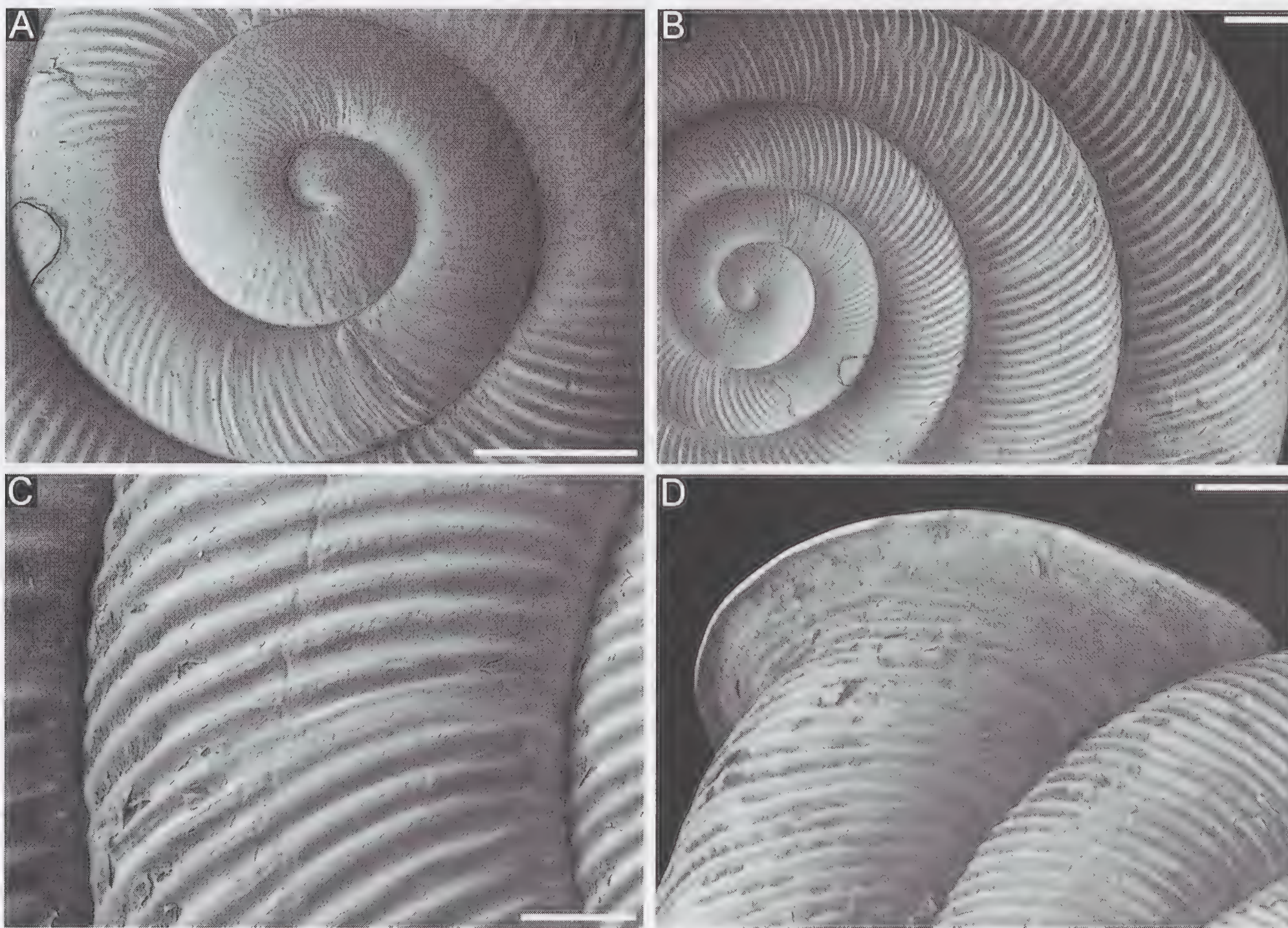


FIG. 177. SEM micrographs of the shell of *Torresitrachia allouarni* n. sp. paratype AM C471771 (SE Augustus Island). A: Apical view showing protoconch and first whorl; B: Sculpture across entire shell viewed from above; C: Close-up of sculpture on penultimate whorl; D: Close-up of sculpture on last whorl near aperture. Scale bars A–B, D = 1 mm; C = 500 µm.

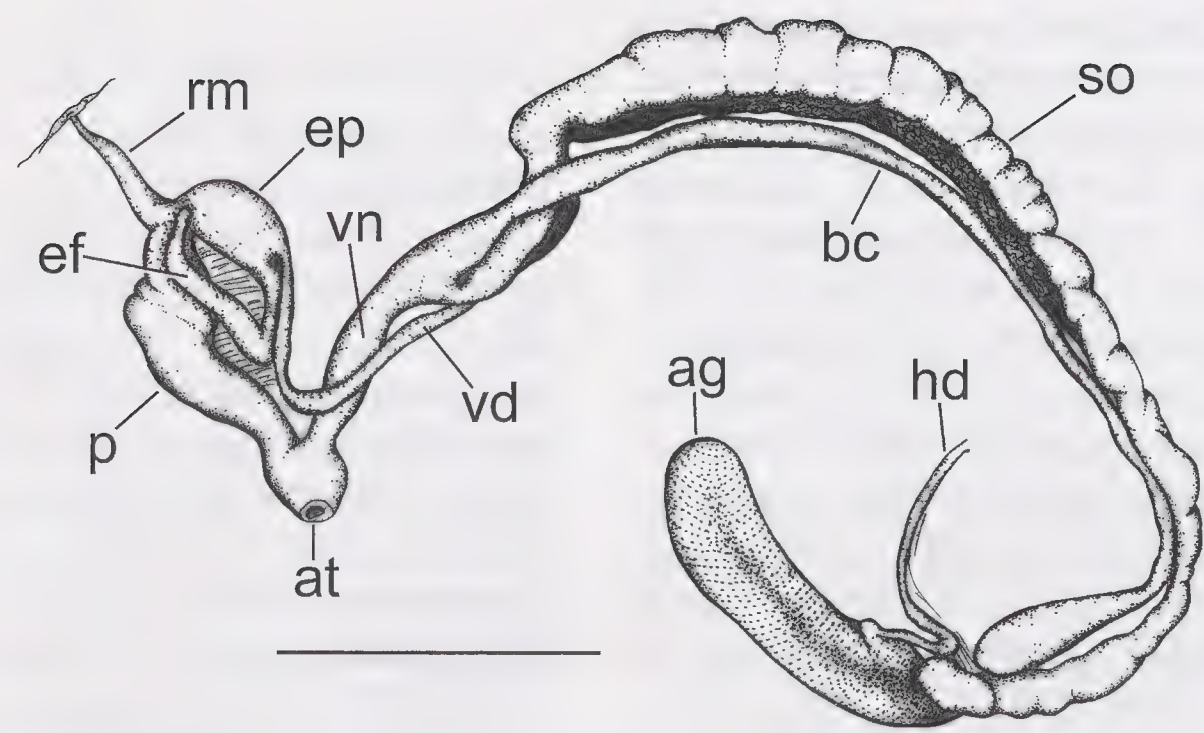


FIG. 178. Genital anatomy of *Torresitrachia allouarni* n. sp. paratype AM C471770 (SE Augustus Island, February). Scale bar = 5 mm.

Description

Shell (Figs. 161F, 177): Moderate in size ($D = 14.7$ mm on average; Table 10), discoidal to very broadly conical with almost flat to weakly elevated spire; umbilicus ~ 3 mm wide; colour brownish horn. Protoconch ~ 2.3 mm in diameter, comprising about one whorl, with weak radial pustulation. Teleoconch with very fine, regularly and narrowly spaced radial ribs, becoming indistinct below periphery and extend-

ing as weak growth lines onto base of shell; inner umbilical whorls essentially smooth, very sparsely covered with periostracal pustules; fine pustules directly underneath suture. Apertural lip sharp to thickened, weakly to well expanded, weakly reflected, well rounded without nodes, parietal wall extremely delicate.

Genital anatomy (Figs. 178–179): Penis as long as vagina, straight. Epiphallus about same length, with long, narrow epiphallallic flagellum. Distal end of inner penial wall with few, small, pustules, densely arranged in honeycomb pattern; most of inner wall smooth with two well-defined longitudinal pilasters, situated next to each other and fused at either end. Inner epiphallallic wall with five longitudinal pilasters, rest of epiphallallic wall covered with dense, fine pustulation. Penial retractor muscle short. Vagina about same length as free oviduct, tubular. Free oviduct moderately long. Bursa copulatrix with slightly inflated head, reaching anterior end of albumen gland.

Mitochondrial Differentiation

Intraspecific genetic distance (4 sequences): 0.004–0.010; interspecific genetic distances: 0.049–0.052 with respect *T. tasmani*; 0.091–0.094 to *T. baudini*, 0.094–0.101 to *T. flindersi*; 0.114–0.135 to *T. aquilonia*, *T. freycineti*, *T. girgarinae*, *T. hartogi* and *T. leichhardti*; 0.217–0.230 to all other congeners.

Comparative Remarks

Shell flatter than in all species treated above, which figures in a lower H/D ratio (Table 10);

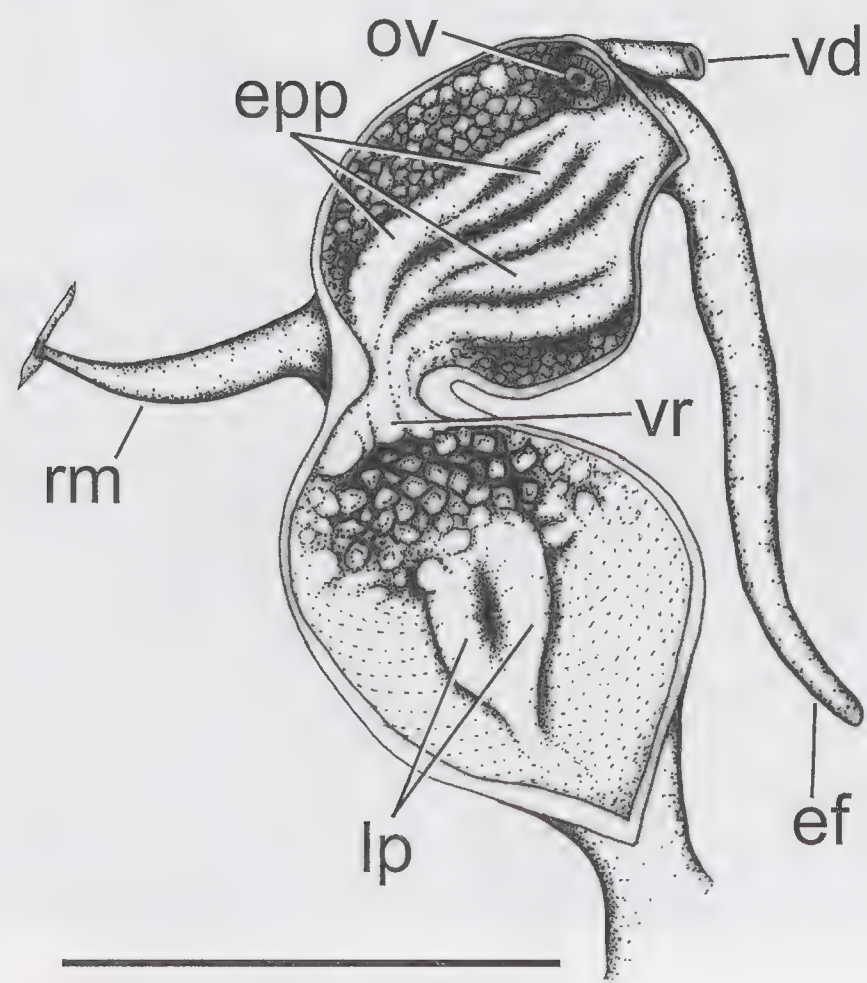


FIG. 179. Penial anatomy of *Torresitrachia allouarni* n. sp. paratype AM C471770 (SE Augustus Island, February). Scale bar = 3 mm.

protoconch with pustulation instead of smooth. Genetically most similar species are found in adjacent areas, such as *T. tasmani* (Byam Martin Island), *T. flindersi* (NW part of Augustus Island), *T. baudini* (islet SE of Augustus Island), all of which are assumed to form a flock of closely related species. *Torresitrachia al-*

louarni reveals distinctive genital features that are not known from any other species, such as pustulation of epiphallic wall and closely adjacent pair of partly fused longitudinal pilasters on inner penial wall. These distinctive features are considered to be indicative of status as distinct species.

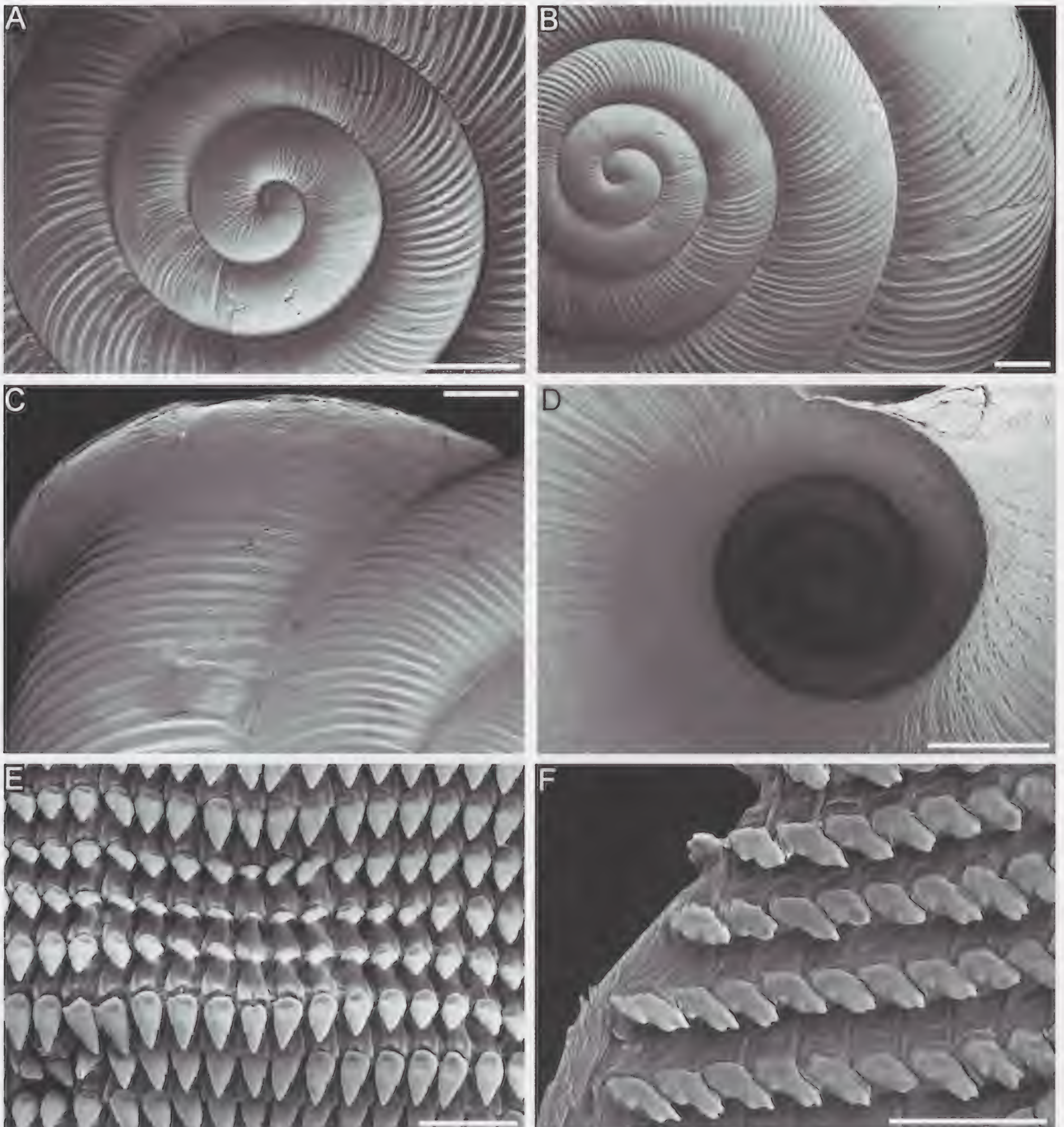


FIG. 180. SEM micrographs of *Torresitrachia flindersi* n. sp. (NW Augustus Island). A–D: Shell paratype AM C471775. Scale bars = 1 mm. A: Apical view showing protoconch and first whorls; B: Sculpture across entire shell viewed from above; C: Close-up of sculpture on last whorl near aperture; D: Umbilicus; E–F: Radula paratype AM C471772. Scale bars = 50 μ m; E: Central and lateral teeth viewed from above; F: Marginal teeth viewed obliquely from above.

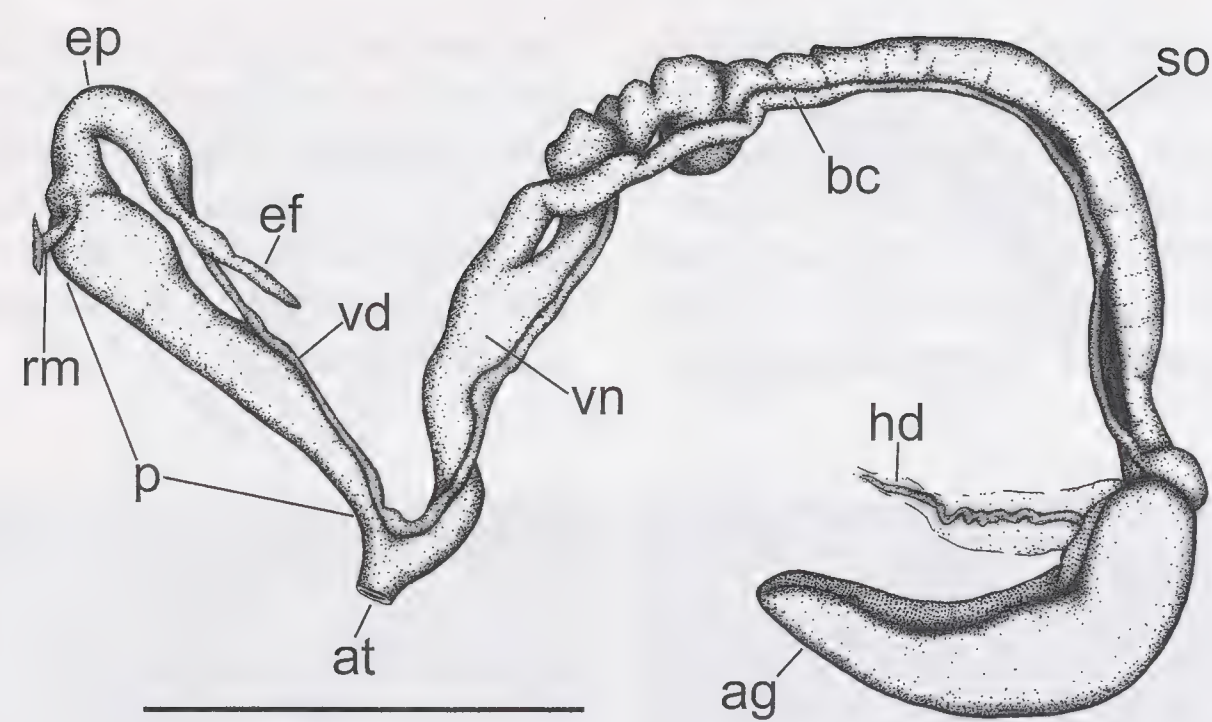


FIG. 181. Genital anatomy of *Torresitrachia flindersi* n. sp. paratype AM C471772 (NW Augustus Island, May). Scale bar = 5 mm.

Distribution

Southeastern portion of Augustus Island. Not found in northern Augustus Island, which is occupied by *T. flindersi*.

WAM S37275 (5 shells) from 15°21'06"S, 124°31'48"E; WAM S37279 (9 shells) from 15°21'24"S, 124°31'39"E; WAM S37220 (5 preserved specimens), WAM S37280 (9 shells) from 15°20'16"S, 124°31'16"E.

Torresitrachia flindersi n. sp.
Figs. 161G–H, 180–182

Type Locality

Western Australia, central Kimberley coast, Bonaparte Archipelago, Camden Sound, NW section of Augustus Island, 15°19'58"S, 124°31'01"E; coll. Michael Shea, 26/05/2008, KIS 1–51 (vine thicket on S-facing rocky slope below sandstone escarpment; inside logs and *Pandanus* stumps on lower slopes).

Material Examined

Holotype WAM S58456 (preserved specimen, Fig. 161G). Paratypes AM C471772 (7 preserved specimens), WAM S37022 (12 preserved specimens), AM C471773 (7 shells), WAM S37282 (14 shells) from type locality; AM C471774 (6 preserved specimens), WAM S37648 (18 preserved specimens) from 15°20'11"S, 124°31'10"E; AM C471775 (5 shells), WAM S37281 (9 shells) from 15°20'04"S, 124°31'01"E; WAM S37021 (5 preserved specimens) from 15°20'04"S, 124°31'01"E.

Additional, non-type material. WAM S37278 (9 shells) from 15°21'05"S, 124°31'36"E; AM C471776 (4 shells), WAM S37277 (12 shells) from 15°21'05"S, 124°31'47"E; WAM S37276 (10 shells) from 15°20'59"S, 124°31'30"E;

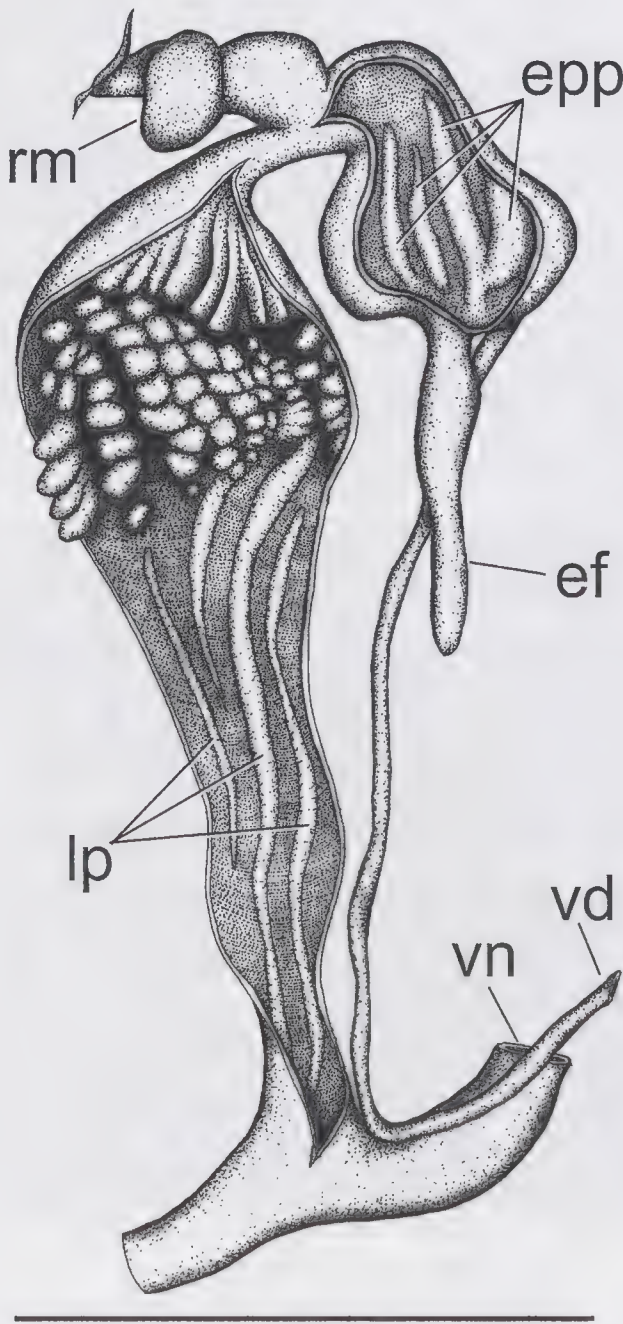


FIG. 182. Penial anatomy of *Torresitrachia flindersi* n. sp. paratype AM C471772 (NW Augustus Island, May). Scale bar = 3 mm.

Etymology

In honour of Matthew Flinders, who circum-navigated Australia together with George Bass in 1798–99; noun in genitive case.

Description

Shell (Figs. 161G, H, 180A–D): Moderate in size ($D = 6.6$ mm on average; Table 10), discoidal to very broadly conical with almost flat to weakly elevated spire; umbilicus ~ 3 mm wide; colour brownish horn. Protoconch ~ 2.4 mm in diameter, comprising about one whorl, with weak, radially arranged pustulation. Teleoconch with very fine, regularly and narrowly spaced radial ribs, becoming indistinct below periphery and extending as weak growth lines onto base of shell; inner umbilical whorls essentially smooth, very sparsely covered with periostracal pustules. Apertural lip sharp, rather weakly expanded and reflected, well rounded without nodes, parietal wall extremely delicate.

Radula (Fig. 180E, F): C + 12–13 + 3–4 + 16–18 ($n = 1$).

Genital anatomy (Figs. 181–182): Penis longer than vagina, straight. Epiphallus tiny, much shorter than penis, with long, narrow epiphallic flagellum. Distal third of inner penial wall with very large, roundish pustules, loosely arranged in longitudinal rows; proximal two thirds with four to five well-defined longitudinal pilasters, only two of them reaching proximal end. Inner epiphallic wall with four to five well-defined longitudinal pilasters, only two of them reaching proximal end. Penial retractor muscle moderate. Vagina about same length as free oviduct. Free oviduct moderately long, coiled. Bursa copulatrix with conspicuously inflated head, reaching anterior end of albumen gland.

Mitochondrial Differentiation

Intraspecific genetic distance (2 sequences): 0.015; interspecific genetic distances: 0.037–0.038 with respect to *T. baudini*; 0.079–0.080

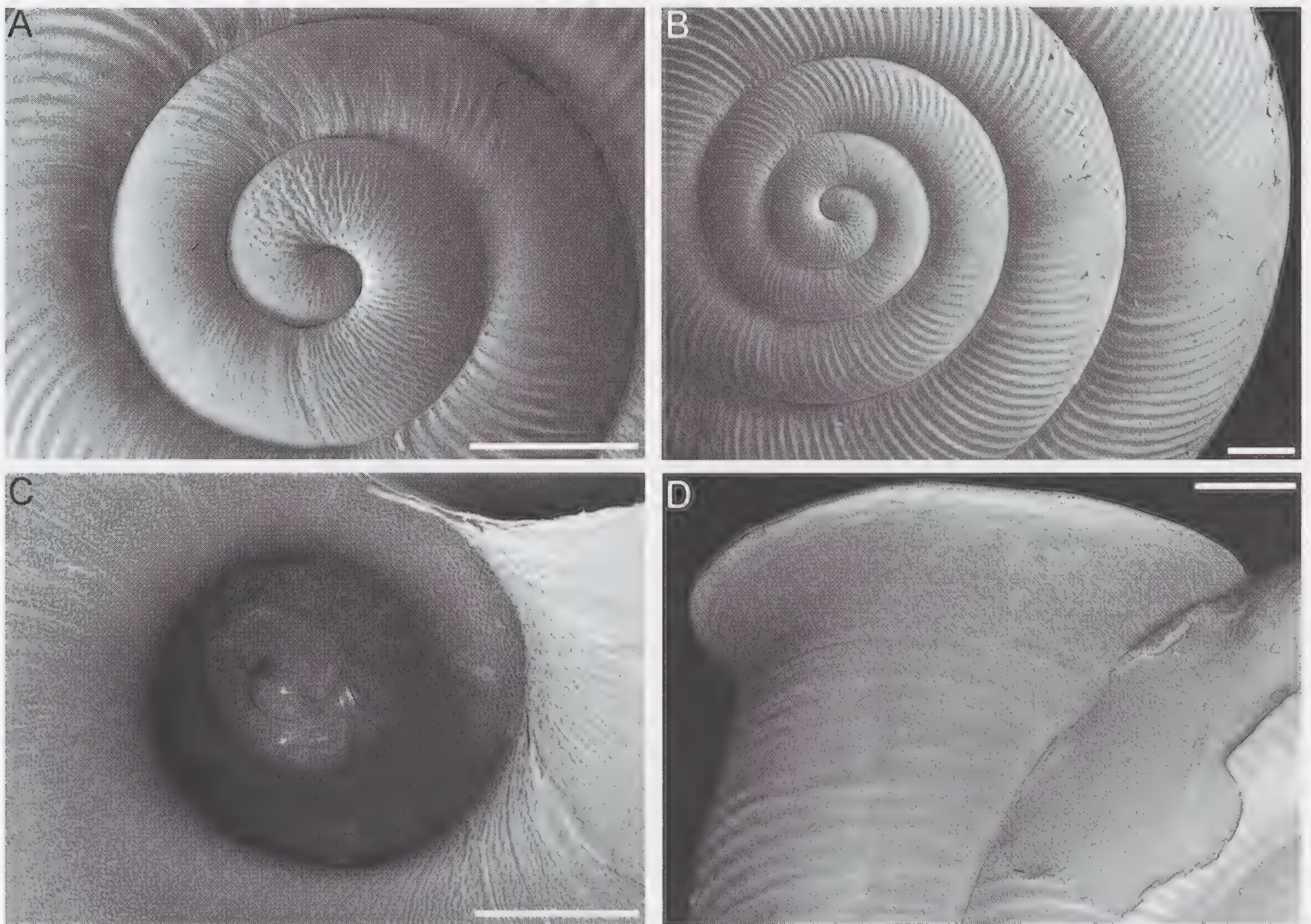


FIG. 183. SEM micrographs of the shell of *Torresitrachia baudini* n. sp. paratype AM C471778 (islet SE of Augustus Island). A: Apical view showing protoconch and first whorl; B: Sculpture across entire shell viewed from above; C: Umbilicus; D: Close-up of sculpture on last whorl near aperture. Scale bars = 1 mm.

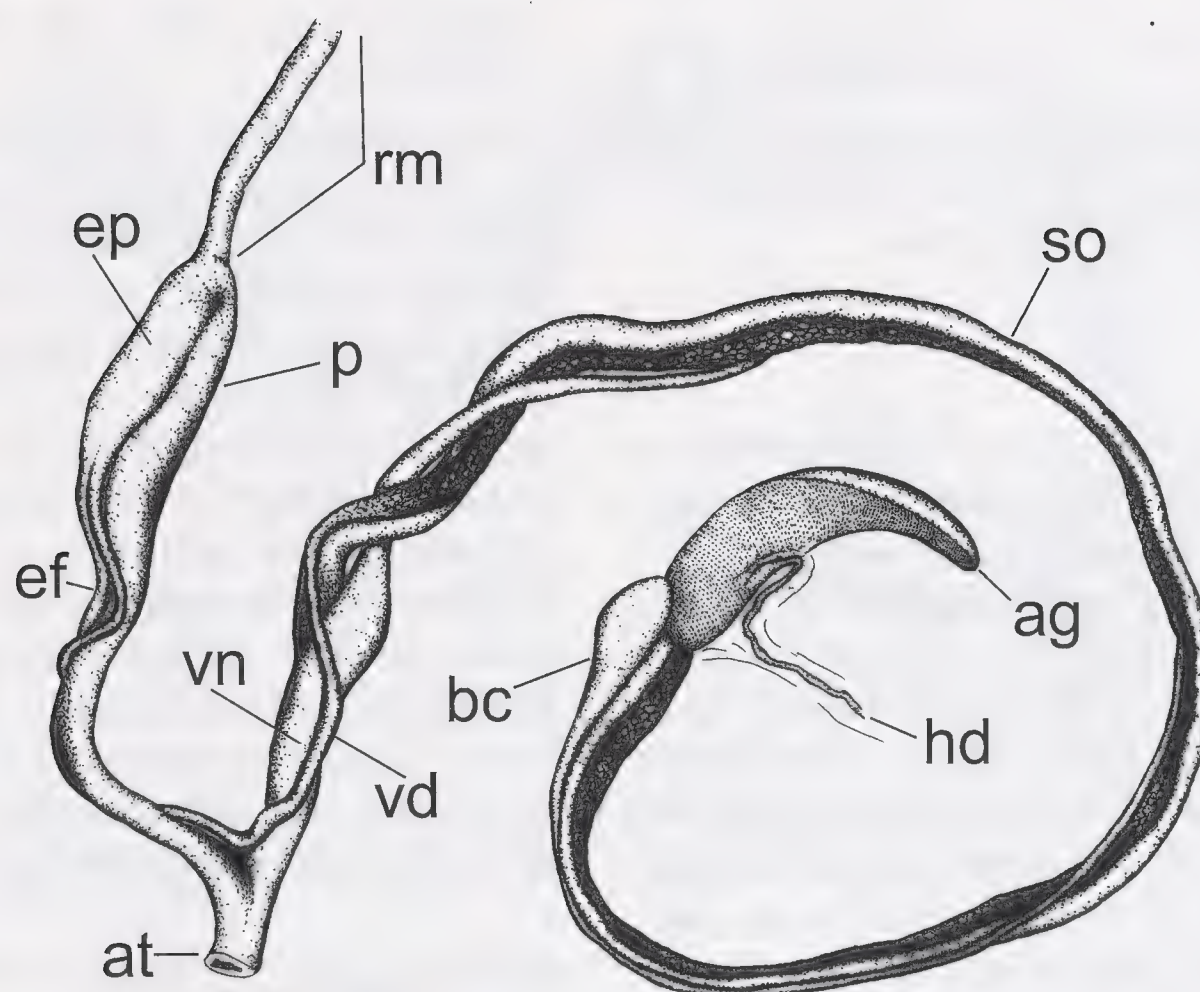


FIG. 184. Genital anatomy of *Torresitrachia baudini* n. sp. paratype AM C471777 (islet SE of Augustus Island, February). Scale bar = 3 mm.

to *T. tasmani*, 0.094–0.101 to *T. allouarni*; 0.109–0.135 to *T. aquilonia*, *T. freycineti*, *T. girgarinae*, *T. hartogi* and *T. leichhardtii*; 0.217–0.230 to all other congeners.

Comparative Remarks

Most similar to *T. allouarni*, both species having comparatively flat shells (i.e., low H/D ratio, Table 10); protoconch with pustulation instead of smooth. Both species belong to a complex of species that are separated by relatively low genetic distances of about 0.05 to 0.10. Genetically most similar is *T. baudini*. It differs by more extended pustulation and not as well-developed longitudinal pilasters of inner penial wall; for comparison with *T. allouarni* see above. In general, penial wall sculpture is similar to *T. aquilonia* (with smaller pustules, indistinct pilasters), *T. urvillei* (smaller pustules, broader and fewer pilasters), and *T. brookei* (smaller pustules and indistinct pilasters). Typical of *T. flindersi* are rhomboid, elongate shape of pustules, pustulation being restricted to distal quarter of inner penial wall, straight and narrow pilasters along most of penial and epiphallial wall.

Distribution

Northwestern section of Augustus Island, not found in southern portion of the island, which is occupied by *T. allouarni*.

Torresitrachia baudini n. sp.

Figs. 161I, 183–185

Type Locality

Western Australia, central Kimberley coast, Bonaparte Archipelago, Brecknock Harbour, small unnamed island SE of Augustus Island, 15°22'22"S, 124°37'50"E; coll. Vince Kessner, 12/02/2009, KIS 2–70 (vine thicket patch on steep slope above beach, sandstone; under rocks and logs).

Material Examined

Holotype WAM S58457 (preserved specimen, Fig. 161I). Paratypes AM C471777 (3 preserved specimens), WAM S37653 (9 preserved specimens), AM C471778 (15 shells), WAM S49003 (28 shells).

Etymology

In honour of Nicolas Baudin, who lead until then the largest scientific expedition to Western Australia in 1800–1801 on board the ships *Le Géographe* and *Le Naturaliste*; noun in genitive case.

Description

Shell (Figs. 161I, 183): Rather large ($D = 14.8\text{--}17.5$ mm; Table 10), broadly conical with

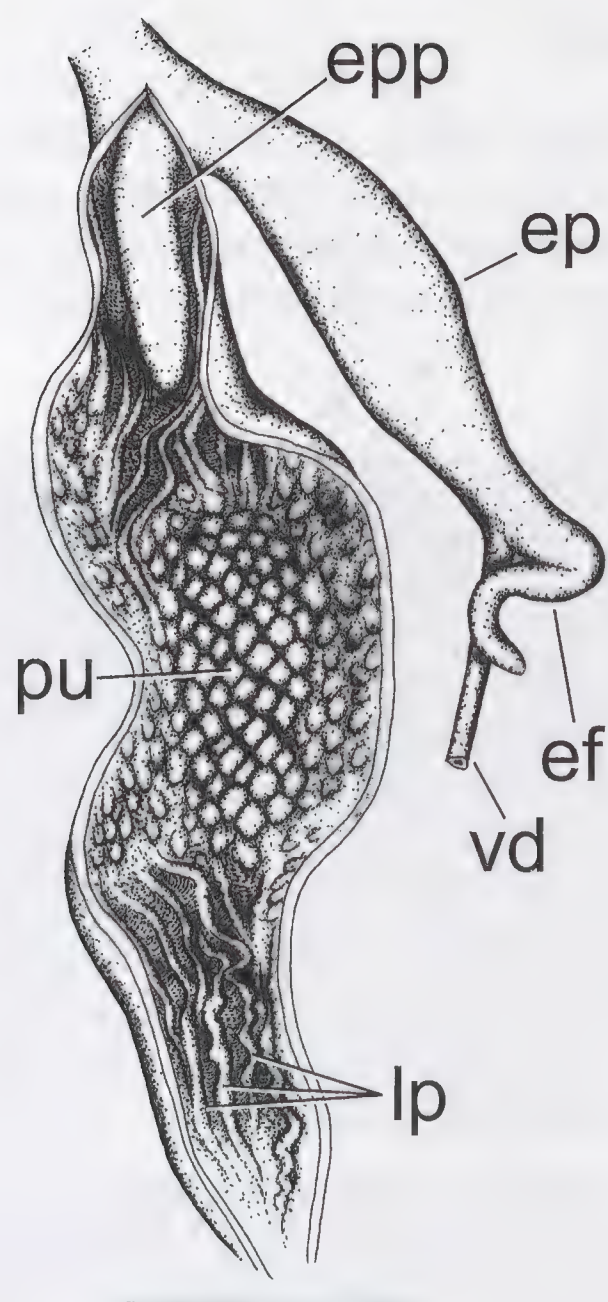


FIG. 185. Penial anatomy of *Torresitrachia baudini* n. sp. paratype AM C471777 (islet SE of Augustus Island, February). Scale bar = 1 mm.

weakly to moderately elevated spire; periphery well rounded to slightly angled, suture shallow; umbilicus ~ 3 mm wide; colour light yellowish-brown to horn. Protoconch ~ 2.3 mm in diameter, comprising about one whorl, with weakly developed radial pustulation. Teleoconch with fine, regularly and narrowly spaced radial ribs, becoming indistinct below periphery and extending as weak growth lines onto base of shell; inner umbilical whorls essentially smooth, very sparsely covered with periostracal pustules; fine pustules directly underneath suture. Apertural lip sharp, weakly expanded and reflected, well rounded without nodes, parietal wall extremely delicate.

Genital anatomy (Figs. 184–185): Penis longer than vagina, tubular, straight. Epiphallus about half as long as penis, with very long, narrow epiphallic flagellum. Distal half of inner penial wall with large, rhomboid pustules, densely arranged in honeycomb pattern; proximal third with five or more thin, partly undulating longitudinal pilasters. Inner epiphallic wall with five or more thin, partly undulating longitudinal pilasters. Penial retractor muscle long. Vagina longer than free oviduct, tubular. Free oviduct

moderately long, coiled. Bursa copulatrix with inflated head, extending anterior end of albumen gland.

Mitochondrial Differentiation

Interspecific genetic distances (1 sequence): 0.077 with respect to *T. flindersi*; 0.079–0.080 to *T. tasmani*, 0.091–0.094 to *T. allouarni*; 0.109–0.135 to *T. aquilonia*, *T. freycineti*, *T. girgarinae*, *T. hartogi* and *T. leichhardti*; 0.217–0.230 to all other congeners.

Comparative Remarks

Similar to *T. allouarni* and *T. flindersi*, shell is rather flat but more elevated and larger than in the former two species. Protoconch of *T. baudini* is comparatively small and has a stronger pustulation than in previous species. Genetic distance to *T. flindersi* is low and not necessarily indicative of distinct species status. However, penial anatomy reveals distinct features that are considered sufficient to treat both as separate species (area of pustulation of penial wall extends much further in *T. baudini* than in *T. flindersi*, distal and proximal portions of wall with many delicate and undulating pilasters). Because these differences are of qualitative but not quantitative nature, they are unlikely to be attributed to seasonal or individual variation in development of structures.

Distribution

Islet southeast of Augustus Island.

Torresitrachia tasmani n. sp. Figs. 161J, 186–188

Type Locality

Western Australia, central Kimberley coast, Bonaparte Archipelago, Camden Sound, Byam Martin Island, 15°23'09"S, 124°21'42"E; coll. Michael Shea, 3/06/2008, KIS 1–61 (dry vine thicket patches, eucalypts on S-facing slope, sandstone; under rocks).

Material Examined

Holotype WAM S58458 (preserved specimen, Fig. 161J). Paratypes AM C471779 (15 preserved specimens), WAM S37026 (36 preserved specimens), WAM S37649 (5 preserved specimens), AM C471780 (7 shells), WAM S37289 (17 shells), WAM S49012 (5 shells) from type locality.

Etymology

In honour of Abel Tasman, the first European explorer, who charted the Western Australian coast between Shark Bay and Cape York in 1644; noun in genitive case.

Description

Shell (Figs. 161J, 186A–D): Rather large ($D = 15.9\text{--}19\text{ mm}$; Table 10), broadly conical with weakly to moderately elevated spire; periphery well rounded to slightly angled, suture shallow;

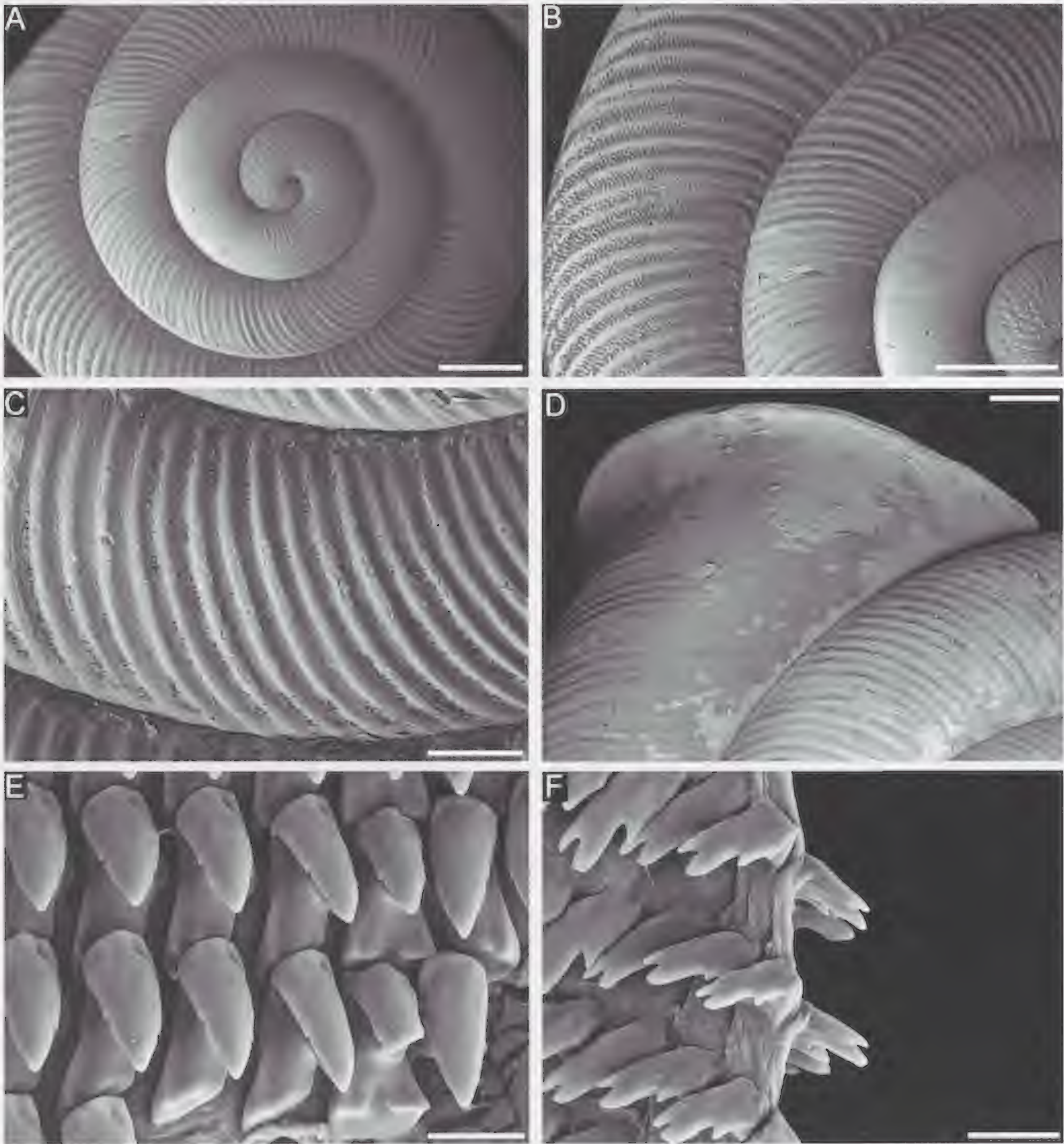


FIG. 186. SEM micrographs of *Torresitrachia tasmani* n. sp. (Byam Martin Island). A–D: Shell paratype AM C471780. A: Apical view showing protoconch and first whorls; B: Sculpture across entire shell viewed from above; C: Close-up of sculpture on penultimate whorl; D: Close-up of sculpture on last whorl near aperture. Scale bars A–B, D = 1 mm, C = 500 μm ; E–F: Radula paratype AM C471779. Scale bars = 20 μm . E: Central and inner lateral teeth; F: Marginal teeth.

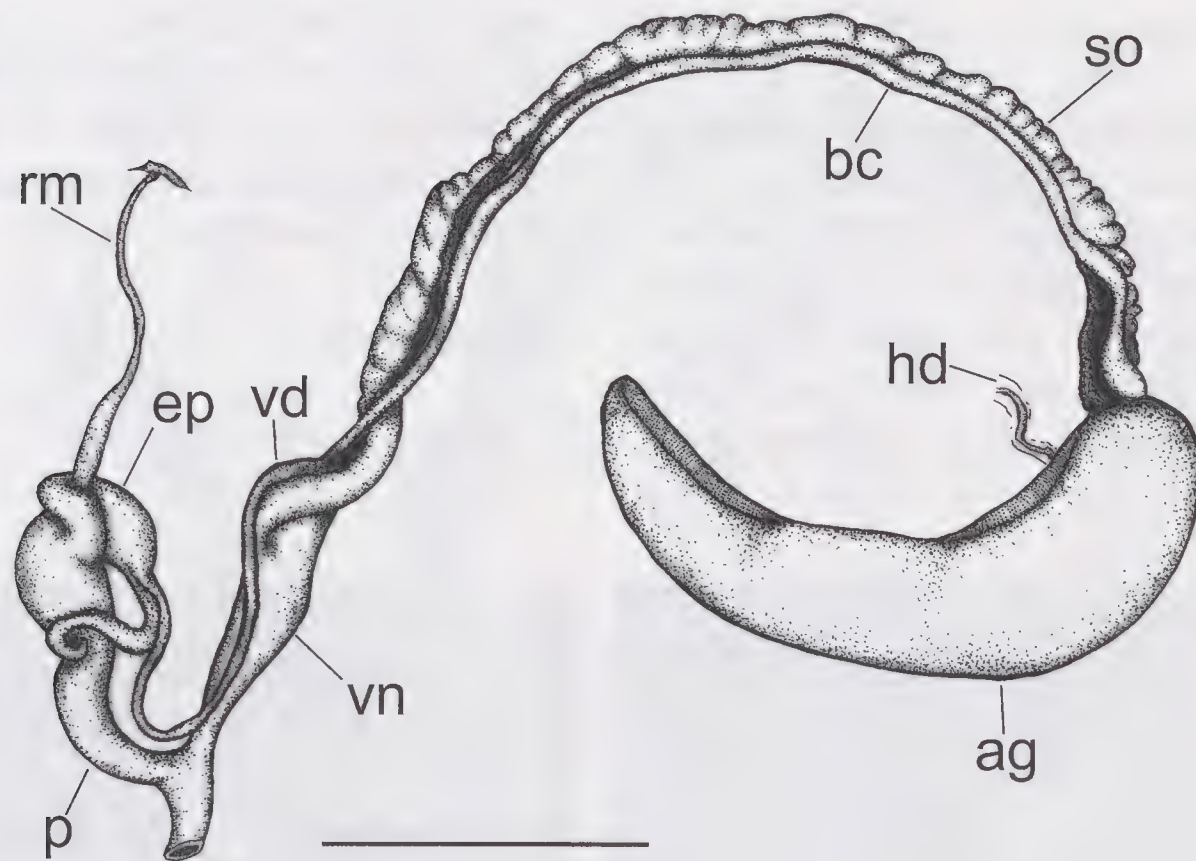


FIG. 187. Genital anatomy of *Torresitrachia tasmani* n. sp. paratype AM C471779 (Byam Martin Island, June). Scale bar = 3 mm.

umbilicus ~ 3 mm wide; colour yellowish-brown. Protoconch ~ 2.3 mm in diameter, comprising about one whorl, with weakly developed radial pustulation. Teleoconch with fine, regularly and narrowly spaced radial ribs, becoming indistinct below periphery and extending as weak growth lines onto base of shell; inner umbilical whorls essentially smooth, very sparsely covered with periostracal pustules; pustules directly underneath suture. Apertural lip sharp, weakly expanded and reflected, well rounded without nodes, parietal wall extremely delicate.

Radula (Fig. 186E, F): C + 18–20 + 2–3 + 18–20.

Genital anatomy (Figs. 187–188): Penis rather as long as vagina), tubular, coiled or winding. Epiphallus slightly shorter than penis, with very long, coiled, narrow epiphallic flagellum. Distal half of inner penial wall with moderate to large, rhomboid pustules, densely arranged in honeycomb pattern; proximal half with six to seven well-developed longitudinal pilasters, two of them reaching the basal end. Inner epiphallic wall with four to five well-developed longitudinal pilasters. Penial retractor muscle long. Vagina longer than free oviduct, tubular, inner wall with longitudinal pilasters. Free oviduct short, coiled. Bursa copulatrix with inflated head, extending anterior end of albumen gland.

Mitochondrial Differentiation

Intraspecific genetic distance (2 sequences): 0.0; interspecific genetic distances: 0.049–0.052 with respect *T. allouarni*; 0.077 to *T. bau-*

dini, 0.079–0.080 to *T. flindersi*; 0.107–0.135 to *T. aquilonia*, *T. freycineti*, *T. girgarinae*, *T. hartogi* and *T. leichhardtii*; 0.217–0.228 to all other congeners.

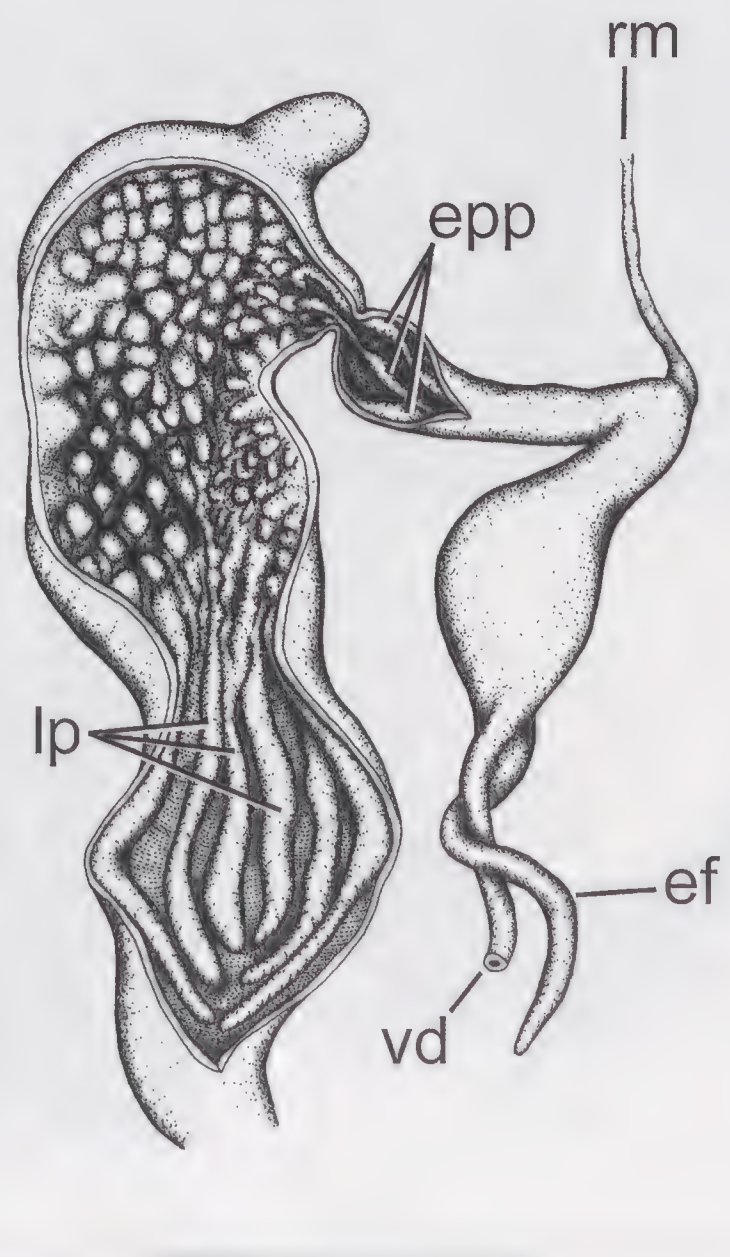


FIG. 188. Penial anatomy of *Torresitrachia tasmani* n. sp. paratype AM C471779 (Byam Martin Island, June). Scale bar = 1 mm.

Comparative Remarks

Shell most similar to *T. baudini* but differing by darker colour plus weaker pustulation of protoconch; shell larger than in most species, with wider umbilicus (except *T. janszi* being of similar size), with more elevated spire than *T. allouarni* and *T. flindersi*. Penial anatomy most similar to *T. flindersi* but pustules smaller

and rounded instead of rhomboid, pilasters of penial and epiphallic walls more strongly developed and closer. *T. baudini* differs by more extended area of pustulation and more indistinct pilasters.

Distribution

Byam Martin Island.

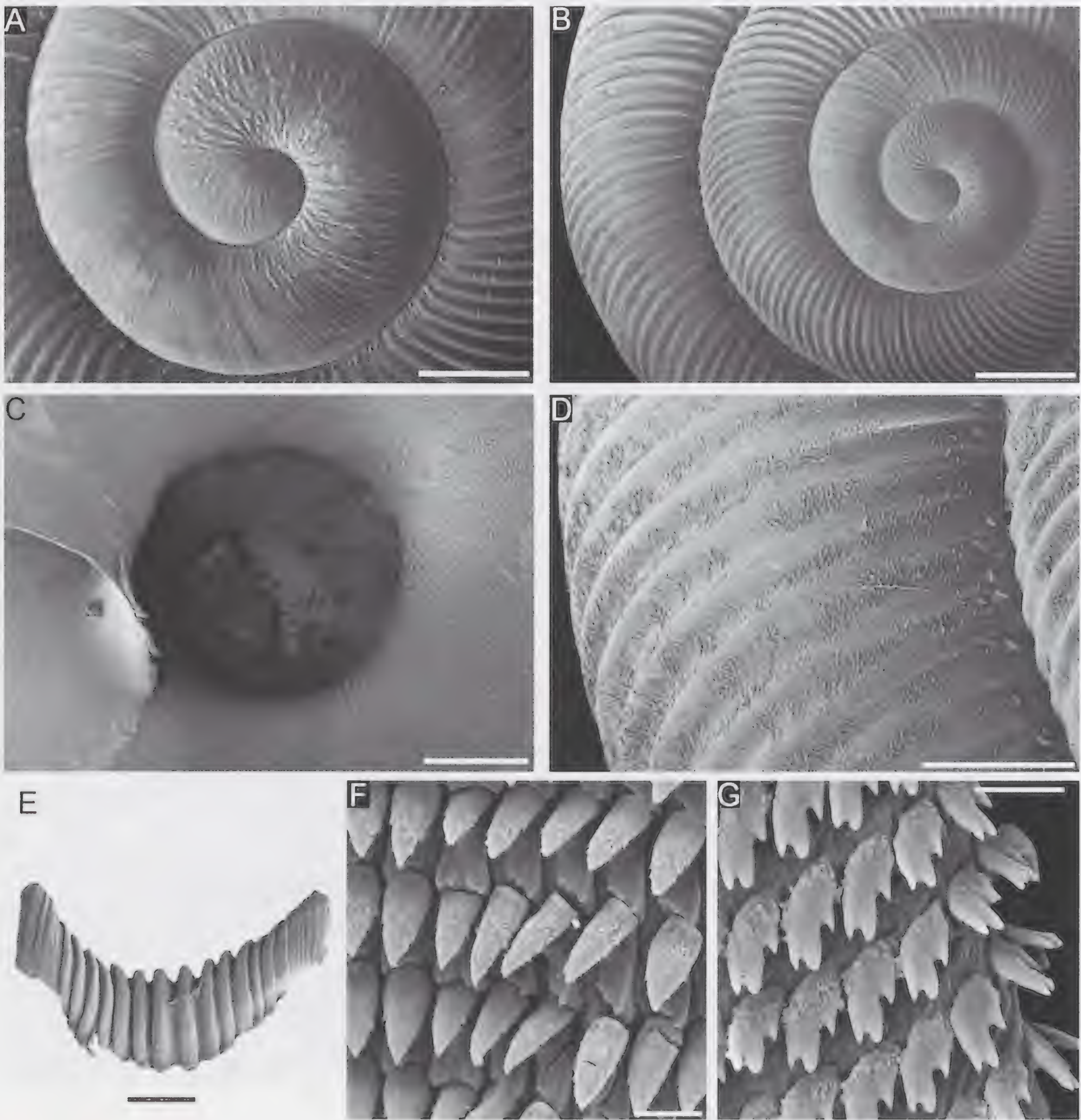


FIG. 189. SEM micrographs of *Torresitrachia freycineti* n. sp. (D'Arcy Island). A–D: Shell paratype AM C471783. A: Apical view showing protoconch and first whorls; B: Sculpture across entire shell viewed from above; C: Close-up of sculpture on penultimate whorl; D: Close-up of sculpture on last whorl near aperture. Scale bars A–B, D = 1 mm, C = 500 μ m; E–F: Radula paratype AM C471781. Scale bars = 20 μ m. E: Central and inner lateral teeth; F: Marginal teeth.

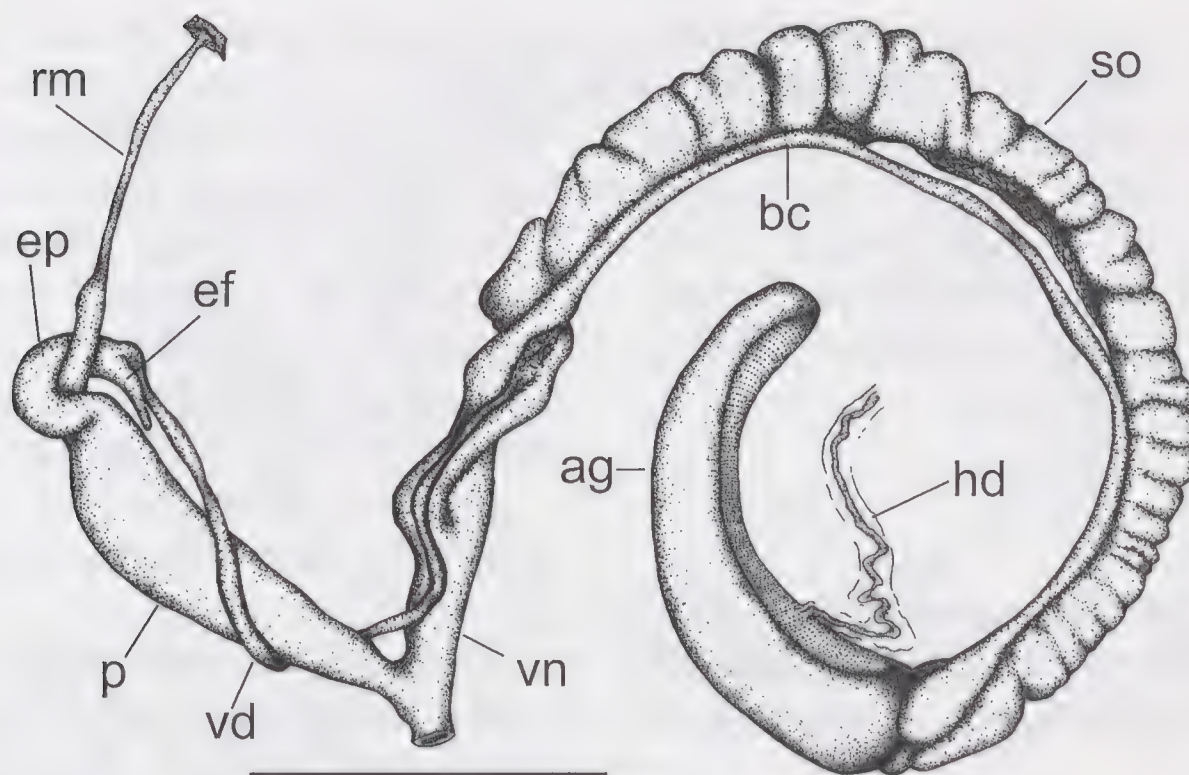


FIG. 190. Genital anatomy of *Torresitrachia freycineti* n. sp. paratype AM C471781 (D'Arcy Island, June). Scale bar = 5 mm.

Torresitrachia freycineti n. sp.
Figs. 161K–L, 189–191

Type Locality

Western Australia, central Kimberley coast, Bonaparte Archipelago, NW section of D'Arcy Island, 15°15'30"S, 124°26'25"E; coll. Roy Teale, 5/06/2008, KIS 2–57 (very small vine thicket in scrubby woodland; aestivating under rocks in loose soil).

Material Examined

Holotype WAM S58459 (preserved specimen). Paratypes AM C471781 (6 preserved specimens), WAM S37015 (13 preserved specimens), WAM S37295 (11 shells) from type locality; AM C471786 (6 preserved specimens), WAM S37012 (19 preserved specimens), WAM S37292 (9 shells) from 15°15'09"S, 124°26'33"E; WAM S37296 (9 shells) from 15°15'30"S, 124°25'57"E; AM C471787 (5 preserved specimens), WAM S37018 (14 preserved specimens) from 15°15'45"S, 124°26'36"E; AM C471782 (10 preserved specimens), WAM S37651 (24 preserved specimens) AM C471783 (10 shells), WAM S49006 (15 shells) from NE section, 15°15'35"S, 124°26'36"E.

Additional, non-type material. WAM S37650 (29 preserved specimens), AM C471784 (15 preserved specimens), WAM S37013 (39 preserved specimens), WAM S37293 (24 shells), WAM S37014 (5 preserved specimens), WAM S37294 (8 shells), WAM S37016 (13 preserved specimens), WAM S37017 (5 preserved specimens), WAM S37301 (8 shells), from

NW section of D'Arcy Island; WAM S37646 (preserved specimen), WAM S37283 (10 shells), AM C471787 (5 preserved specimens),

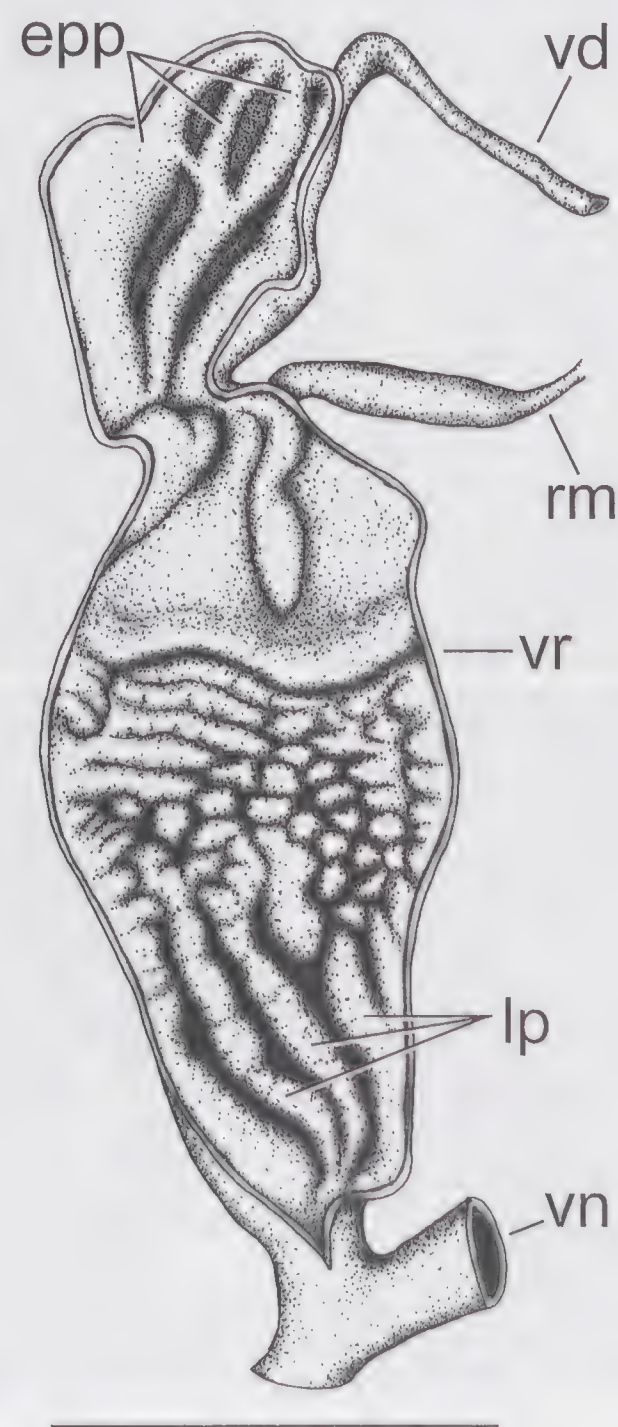


FIG. 191. Penial anatomy of *Torresitrachia freycineti* n. sp. paratype AM C471781 (D'Arcy Island, June). Scale bar = 3 mm.

WAM S37023 (10 preserved specimens), WAM S37284 (38 shells), WAM S37285 (10 shells), WAM S37024 (5 preserved specimens), WAM S37286 (9 shells), WAM S37287 (3 shells), WAM S37025 (preserved specimen), WAM S37288 (4 shells), WAM S37088 (5 preserved specimens), WAM S37089 (preserved specimen), WAM S37290 (3 shells).

Etymology

In honour of Louis de Freycinet, who in 1817 led a large scientific expedition to Western Australia on board the *Uranie*; noun in genitive case.

Description

Shell (Figs. 161K–L, 189A–D): Moderate in size ($D = 12.0\text{--}16.5\text{ mm}$; Table 10), discoidal to very broadly conical with almost flat to weakly elevated spire; umbilicus $\sim 3\text{ mm}$ wide; colour

yellowish-brown. Protoconch $\sim 2.9\text{ mm}$ in diameter, comprising about one whorl, with well-developed radial pustulation. Teleoconch with fine, regularly and narrowly spaced radial ribs; inner umbilical whorls covered with fine periostracal pustules; pustules directly underneath suture. Apertural lip sharp, weakly expanded and reflected, well rounded without nodes, parietal wall extremely delicate.

Digestive anatomy (Fig. 189E–G): Jaw consisting of many plates. Radula C + 10–12 + 16–18.

Genital anatomy (Figs. 190–191): Penis rather longer than vagina, tubular with inflated distal end, straight. Epiphallus much shorter than penis, with short to moderately long, narrow epiphallic flagellum. Distal half of inner penial wall with large, roundish pustules, densely arranged in honeycomb pattern; proximal half with three to five well-developed longitudinal pilasters, two of them reaching proximal end. Inner epiphallic wall with three to

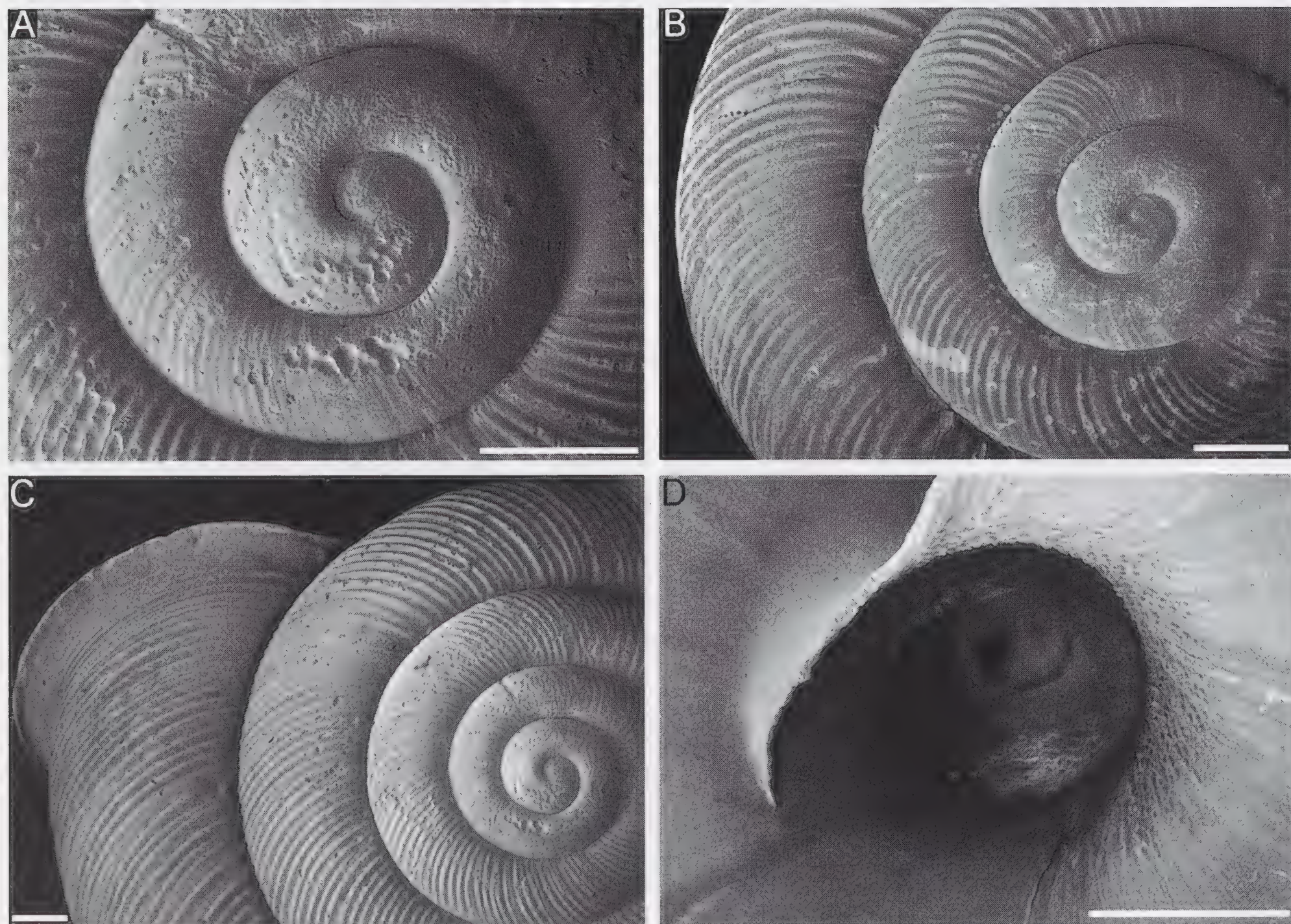


FIG. 192. SEM micrographs of the shell of *Torresitrachia houtmani houtmani* n. sp. & n. subsp. (unnamed island, Doubtful Bay). A–C: Paratype AM C471805. A: Apical view showing protoconch and first whorl; B: Sculpture across entire shell viewed from above; C: Close-up of sculpture on last and penultimate whorls; D: Paratype AM C471807 (juvenile shell), umbilicus. Scale bars = 1 mm.

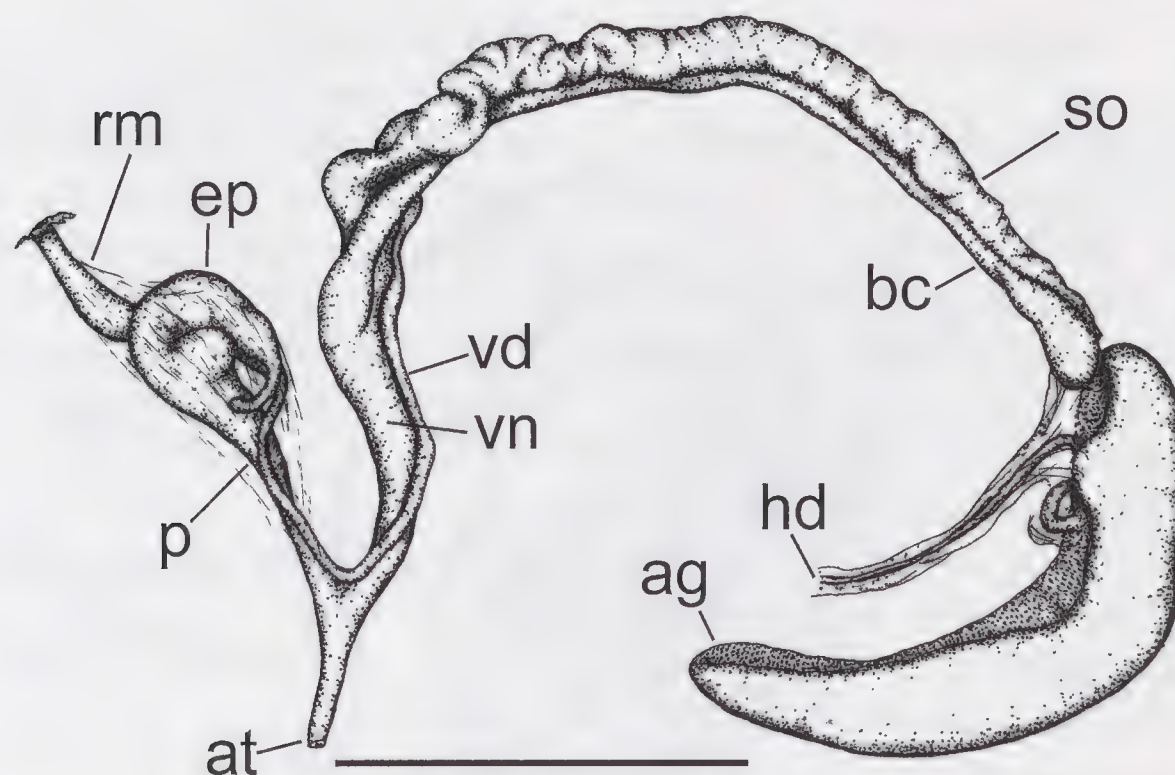


FIG. 193. Genital anatomy of *Torresitrachia houtmani* *houtmani* n. sp. & n. subsp. paratype AM C471801 (unnamed island, Doubtful Bay, May). Scale bar = 5 mm.

four well-developed longitudinal pilasters. Penial retractor muscle moderately long. Vagina about same length as free oviduct, tubular. Free oviduct moderately long, rather straight. Bursa copulatrix with slightly inflated head, reaching anterior end of albumen gland.

Mitochondrial Differentiation

Intraspecific genetic distance (3 sequences): 0.001–0.008; interspecific genetic distances: 0.107–0.140 with respect to *T. allouarni*, *T. aquilonia*, *T. flindersi*, *T. girgarinae*, *T. leichhardti* and *T. tasmani*; 0.204–0.228 to all other congeners.

Comparative Remarks

Closely related with species from Augustus and Byam Martin islands as judged by relatively low genetic distances. Typical features are comparatively long penis, crowded, large pustules and thick pilasters of penial wall plus thick pilasters of epiphallic wall.

Distribution

D'Arcy Island.

Torresitrachia houtmani houtmani

n. sp. & n. subsp.

Figs. 161M, 192–194

Two similar morphs were found in the Collier Bay area, one each on unnamed island, Doubtful Bay as well as Kingfisher Island, Wood

Islands. These forms widely correspond in shell and genital anatomy showing only subtle but consistent differentiation with regard to shell and anatomy of inner penial wall. Preliminary analyses of mitochondrial sequences revealed forms to be mutually monophyletic with relatively low genetic distances of ~ 2%. Consistency of differences and mutual monophyly of the two forms suggests that both represent independent evolutionary entities. However, low rates of differentiation imply that reproductive incompatibility might be incomplete. From a taxonomical point of view, treatment of two allopatric forms as geographical races of a single species is considered the best way to reflect their potentially transitional nature as biological species *sensu* Mayr (1942, 1963).

Type Locality

Western Australia, southwestern Kimberley, Buccaneer Archipelago, unnamed island in Doubtful Bay, 15°54'26"S, 124°28'00"E, coll. Vince Kessner, 29/05/2009, KIS 3–159 (dry woodland on sandstone, in piles of rocks; free sealer).

Material Examined

Holotype WM S58463 (preserved specimen, Fig. 161M). Paratypes WAM S37765 (16 preserved specimens), AM C471801 (6 preserved specimens), WAM S37879 (18 shells), AM C471802 (10 shells), WAM S37758 (16 shells), WAM S37758 (4 preserved specimens), WAM S37872 (10 shells), AM C471803 (8 shells),

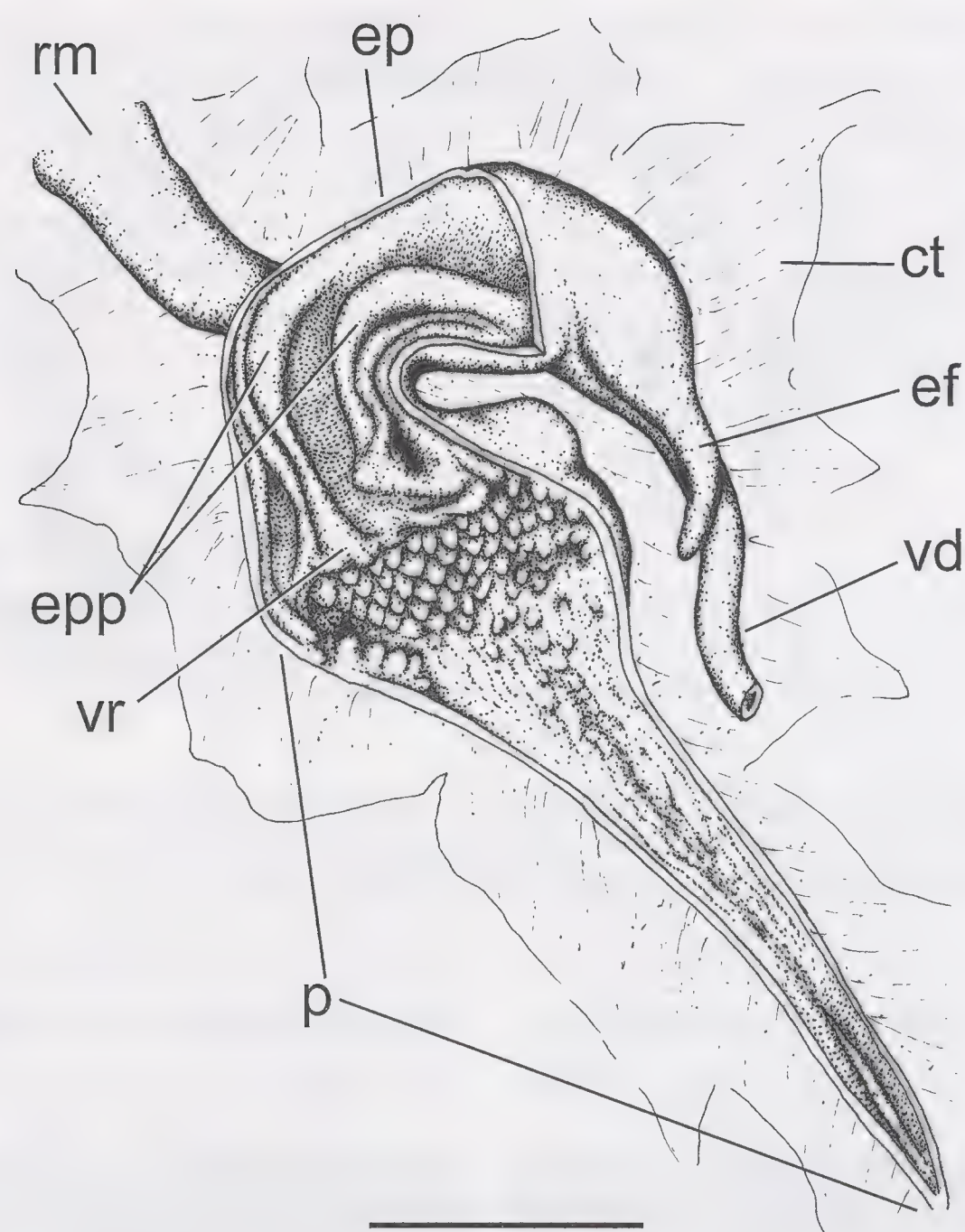


FIG. 194. Penial anatomy of *Torresitrachia houtmani* *houtmani* n. sp. & n. subsp. paratype AM C471801 (unnamed island, Doubtful Bay, May). Scale bar = 1 mm.

WAM S37759 (shell), WAM S37873 (2 shells), WAM S37760 (5 preserved specimens), WAM S37814 (14 shells), AM C471804 (10 shells), WAM S37761 (4 preserved specimens), WAM S37875 (12 shells), AM C471805 (7 shells), WAM S37876 (preserved specimen), WAM S37762 (3 preserved specimens), WAM S37877 (7 shells), WAM S37763 (shell), WAM S37764 (12 preserved specimens), AM C471806 (6 preserved specimens), WAM S37878 (10 shells), AM C471807 (5 shells), WAM S37766 (preserved specimen), WAM S37880 (3 shells), WAM S37881 (10 shells), WAM S37777 (2 preserved specimens), WAM S37882 (7 shells), WAM S37778 (preserved specimen), WAM S37883 (4 shells) all from type locality or very close by on unnamed island, Doubtful Bay.

Etymology

Named in honour of Frederick de Houtman who landed on the Western Australian shore in 1619; noun in genitive case.

Description

Shell (Figs. 161M, 192): Moderate to large in size ($D = 13.9\text{--}18.0\text{ mm}$; Table 10), broadly conical with moderately elevated spire; umbilicus $\sim 2.3\text{ mm}$ wide, not or partly concealed; colour light yellowish-brown, glossy. Protoconch $\sim 2.2\text{ mm}$ in diameter, comprising about one whorl, essentially smooth with erosion scars. Teleoconch with very fine, regularly and narrowly spaced radial ribs, becoming indistinct on base of shell; inner umbilical whorls covered with fine periostracal pustules. Apertural lip sharp, weakly to well expanded, weakly reflected, well rounded without nodes, parietal wall extremely delicate.

Genital anatomy (Figs. 193–194): Penis short and thin (shorter than vagina), with inflated distal end, straight. Epiphallus shorter than penis, with short epiphallal flagellum. Distal end of inner penial wall with small, roundish pustules, loosely arranged in honeycomb pattern, tapering proximally, giving rise to very indistinct, irregularly undulating, indistinct longitudinal

pilasters along proximal three quarters of interior wall. Inner epiphallic wall with two pairs of narrowly attached longitudinal pilasters. Penial complex completely embedded in thick layer of connective tissue. Penial retractor muscle short. Vagina longer than free oviduct, tubular. Free oviduct short, S-shaped. Bursa copulatrix with slightly inflated head, reaching anterior end of albumen gland.

Torresitrachia houtmani dampieri

n. subsp.

Figs. 161N, 195–197

Type Locality

Western Australia, southwestern Kimberley, Buccaneer Archipelago, Collier Bay, Woods Islands, Kingfisher Island, 16°05'21.8"S, 124°05'34.3"E; coll. Vince Kessner, 05/06/2009, KIS 3–173 (rocky band at beach, aestivating deep under rocks, free sealer).

Material Examined

Holotype WAM S58462 (preserved specimen, Fig. 161N). Paratypes WAM S37771 (4 preserved specimens), WAM S37861 (8 shells), AM C471796 (6 shells), WAM S37767 (5 preserved specimens), WAM S37854 (10 shells), AM C471797 (6 shells), WAM S37855 (2 shells), WAM S37856 (3 shells), WAM S37857 (7 shells), WAM S37768 (2 preserved specimens), WAM S37858 (11 shells), WAM S37769 (2 preserved specimens), WAM S37859 (14 shells), AM C471798 (10 shells), WAM S37770 (7 preserved specimens), WAM S37860 (22 shells), AM C471799 (10 shells) from type locality or very close by.

Etymology

Named in honour of William Dampier, first Englishman to land on the northwest coast of what was then called New Holland in 1688; noun in genitive case.

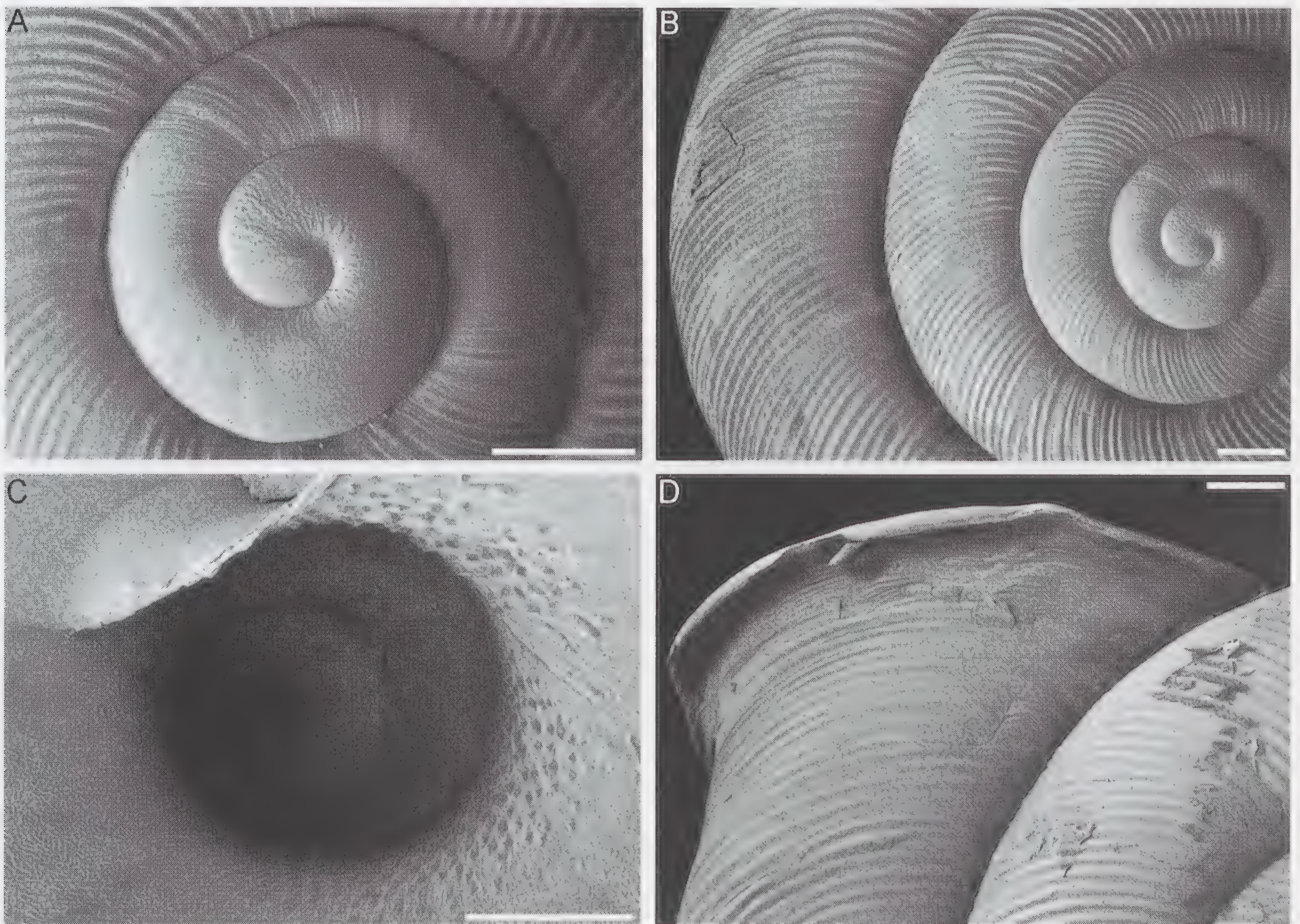


FIG. 195. SEM micrographs of the shell of *Torresitrachia houtmani dampieri* n. subsp. paratype AM C471799 (Kingfisher Island). A: Apical view showing protoconch and first whorl; B: Sculpture across entire shell viewed from above; C: Umbilicus; D: Close-up of sculpture on last whorl near aperture. Scale bars = A–B, D = 1 mm, C = 500 µm.

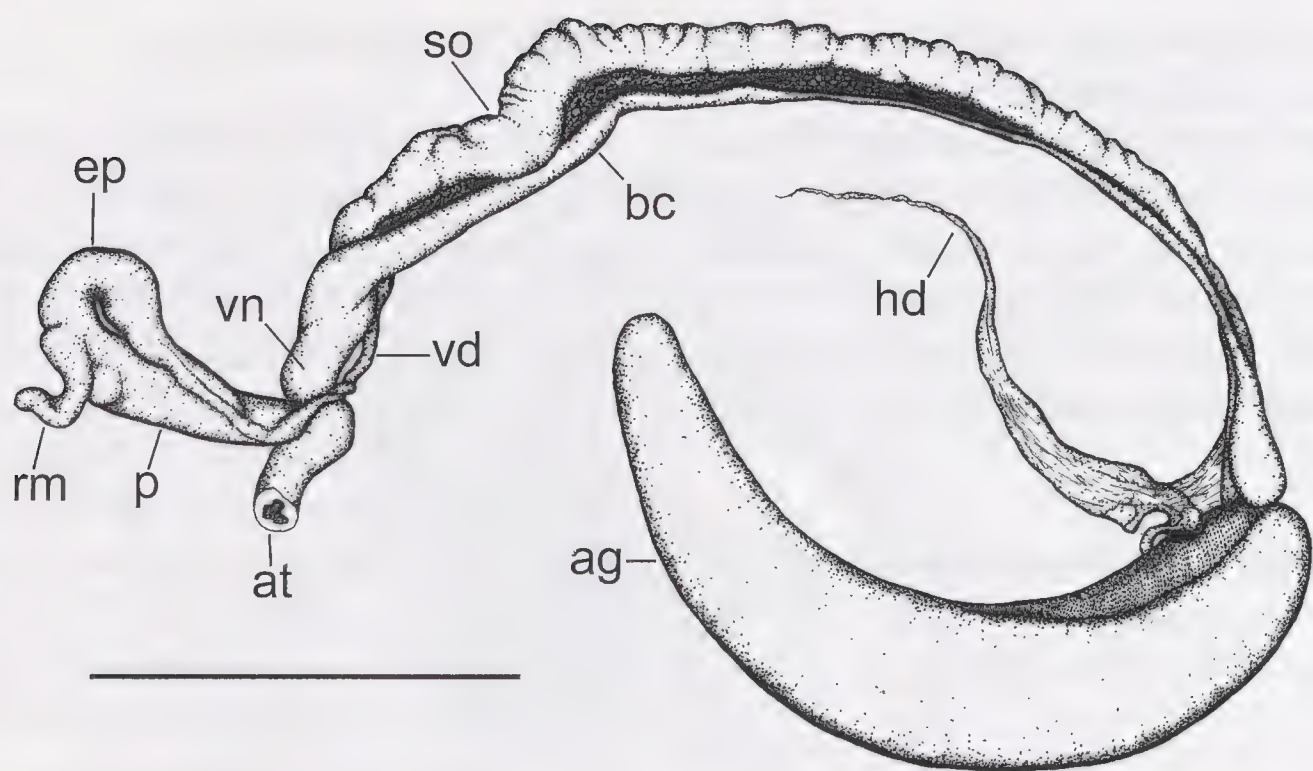


FIG. 196. Genital anatomy of *Torresitrachia houtmani dampieri* n. subsp. paratype WAM S37770 (Kingfisher Island, June). Scale bar = 5 mm.

Description

Shell (Figs. 161N, 197): Moderate to large in size (D = 15.8–18.8 mm; Table 10), umbilicus ~ 2.5 mm wide.

Genital anatomy (Figs. 196–197): Epiphallus slightly shorter than penis, with moderately long epiphallic flagellum. Distal end of inner penial wall with few, small rhomboid pustules, distal three quarters with four well-developed longitudinal pilasters, two of which reach proximal end. Vagina about same length as free oviduct, tubular.

Mitochondrial Differentiation

Intraspecific genetic distance (3 sequences): 0.001–0.003 among nominate form, 0.019–0.021 with respect to *T. houtmani dampieri* (2 sequences); interspecific genetic distances: 0.103–0.108 to *T. urvillei* (3 sequences), 0.104–0.107 to *T. brookei* (2 sequences), 0.0.205–0.245 to all other congeners (22 sequences, 8 species).

Comparative Remarks

Together with *T. janszi* and *T. hartogi* among the largest species of the genus. Typical features of this species are: penis embedded into strong connective tissue, which is more delicate in other species, paired epiphallic pilasters. *Torresitrachia houtmani dampieri* differs from nominate form by larger shell, fewer penial wall pustules of different shape, more pronounced longitudinal pilasters.

Distribution (Fig. 160)

Known from Collier Bay area; the nominate form is found on un-named island in Doubtful Bay (nominate form), and Kingfisher Island, about 40 km to the SW (*T. houtmani dampieri*).

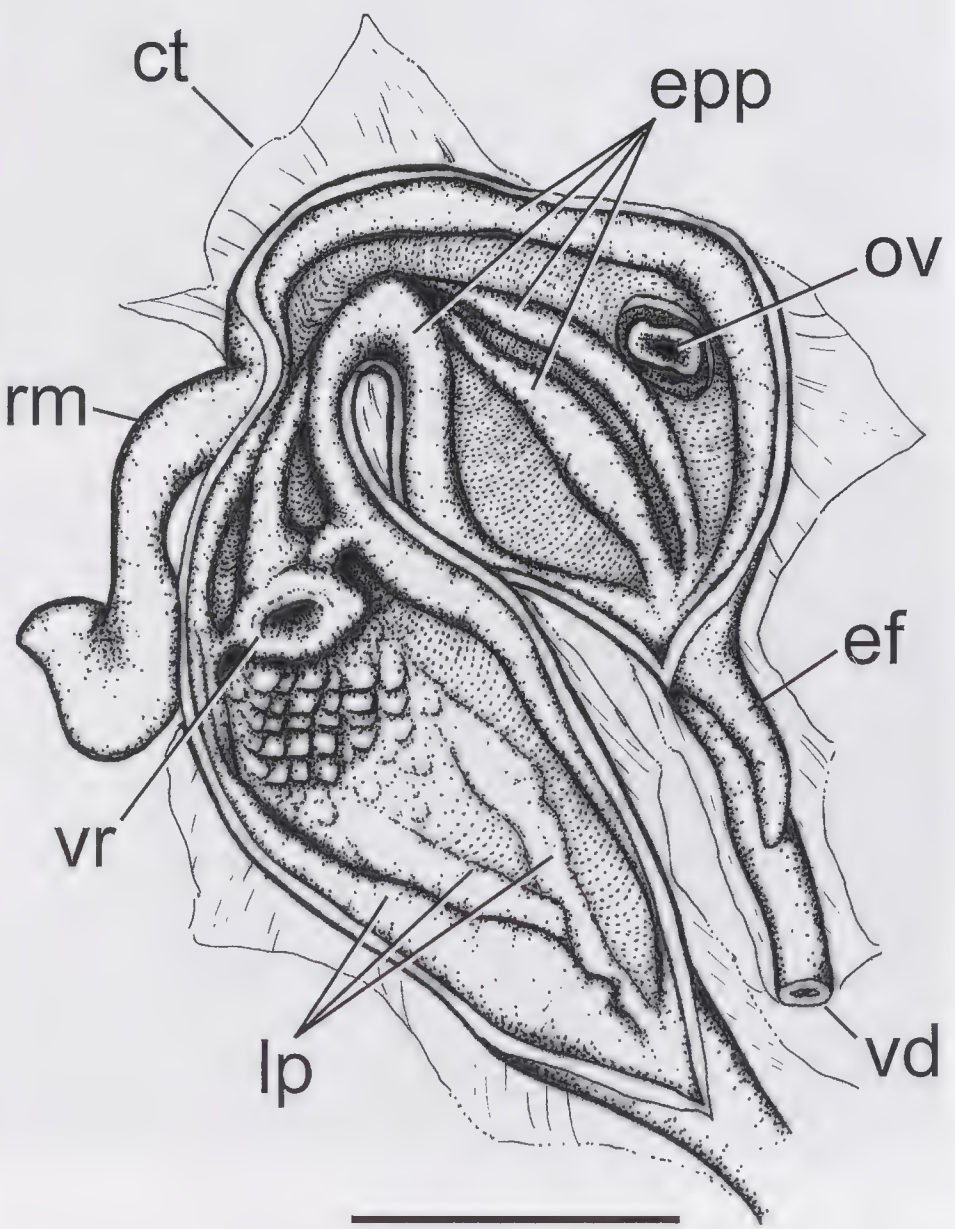


FIG. 197. Penial anatomy of *Torresitrachia houtmani dampieri* n. subsp. paratype WAM S37770 (Kingfisher Island, June). Scale bar = 1 mm.

***Torresitrachia leichhardti* n. sp.**
Figs. 161O, 198–200

Type Locality

Western Australia, southwestern Kimberley, Doubtful Bay, SE section of Storr Island, 15°57'09"S, 124°33'48"E; coll. Vince Kessner, 20/05/2009, KIS 3–138 (vine thicket on lower slope, scrub in a gully; sandstone; under rocks in litter and loose soil).

Material Examined

Holotype WAM S58460 (preserved specimen, Fig. 161O). Paratypes AM C471788 (5 preserved specimens), WAM S37749 (9 preserved specimens), WAM S37844 (27 shells), AM C471789 (15 shells), WAM S37748 (10 preserved specimens), WAM S37843 (14 shells), AM C471790 (6 shells), WAM S37750 (13 preserved specimens), AM C471790 (5 pre-

served specimens), WAM S37845 (18 shells), AM C471791 (7 shells), WAM S37751 (3 preserved specimens), WAM S37847 (13 shells), WAM S37752 (2 preserved specimens), WAM S37848 (7 shells), WAM S37753 (3 preserved specimens), WAM S37849 (8 shells), AM C471793 (4 shells), WAM S37754 (preserved specimen), WAM S37755 (preserved specimen), WAM S37850 (7 shells), WAM S37756 (preserved specimen), WAM S37852 (6 shells), WAM S37757 (2 preserved specimens), WAM S37853 (5 shells), WAM S37834 (3 shells), WAM S37772 (2 preserved specimens), WAM S37851 (5 shells), WAM S37846 (11 shells) from SE section of Storr Island.

Etymology

Named in honour of Ludwig Leichhardt (1813–1848), a German explorer and scientist who got lost in 1844 when attempting to travel inland from Brisbane to Perth; noun in genitive case.

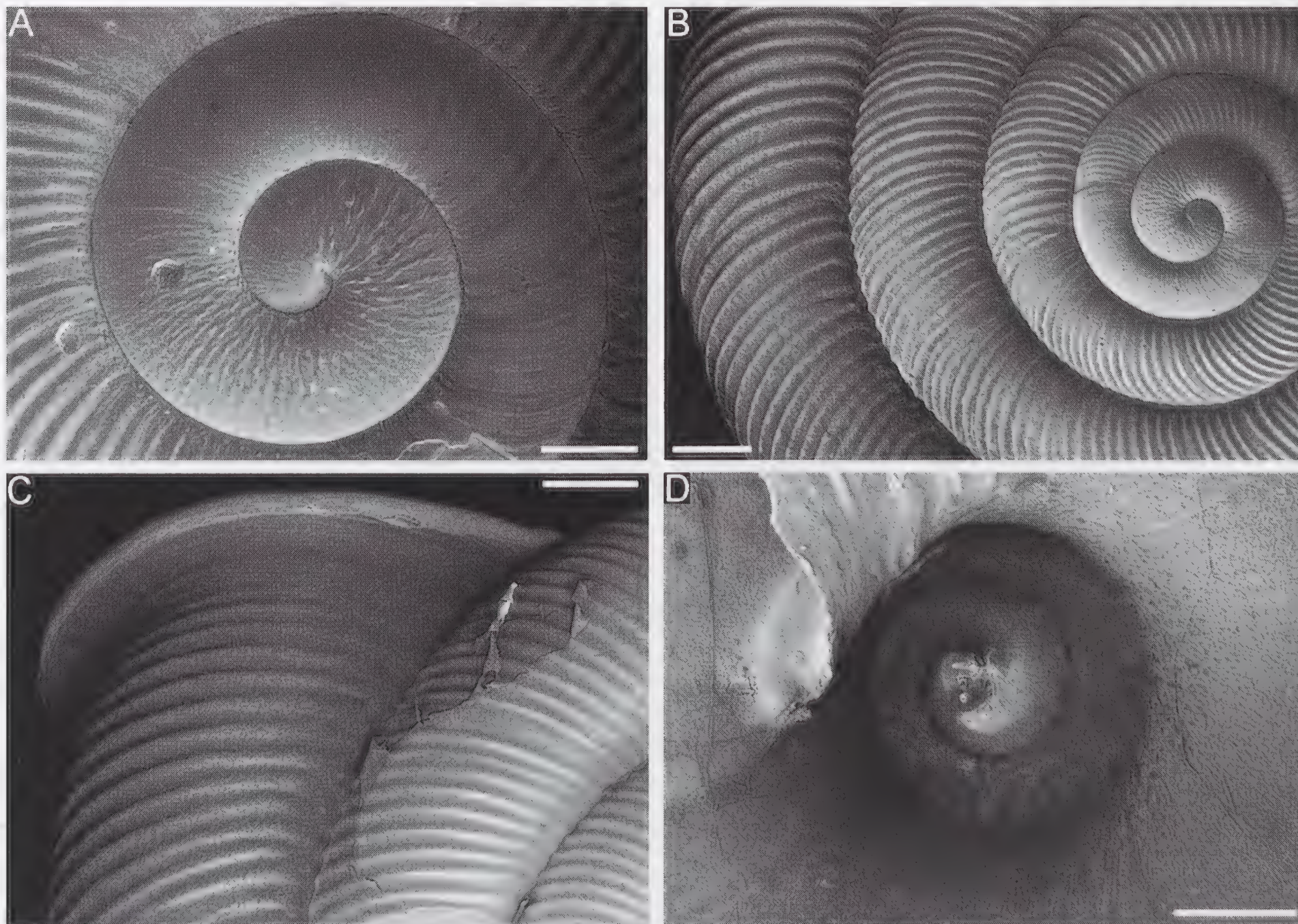


FIG. 198. SEM micrographs of the shell of *Torresitrachia leichhardti* n. sp. paratype AM C471789 (Storr Island). A: Apical view showing protoconch; B: Sculpture across entire shell viewed from above; C: Close-up of sculpture on last whorl near aperture; D: Umbilicus. Scale bars = A, D = 1 mm, B–C = 500 µm.

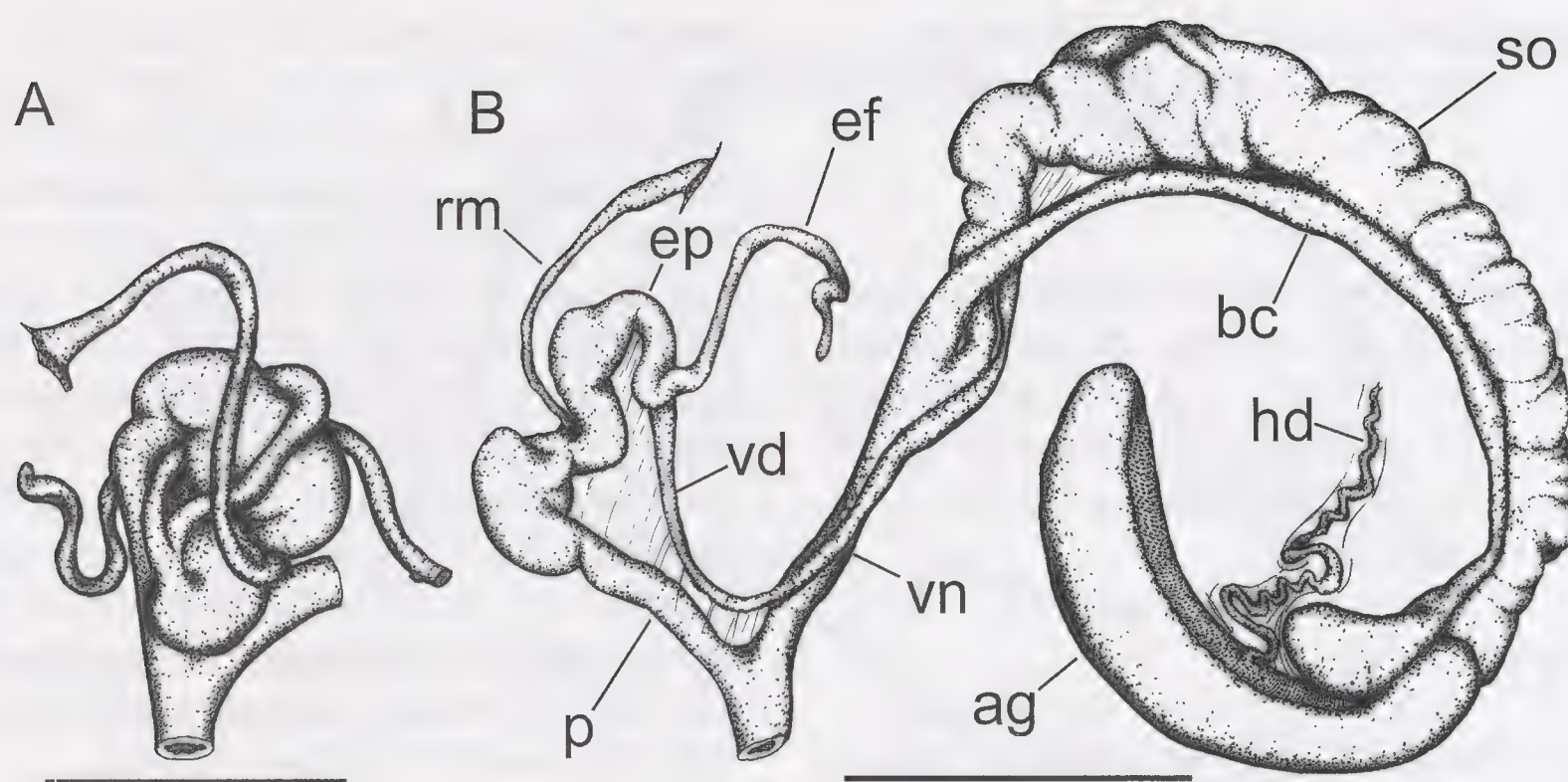


FIG. 199. Genital anatomy of *Torresitrachia leichhardti* n. sp. paratype AM C471791 (Storr Island, May). Scale bar = 5 mm.

Description

Shell (Figs. 161O, 198): Moderate in size ($D = 12.1\text{--}15.4$ mm; Table 10), discoidal to very broadly conical with almost flat to weakly elevated spire; umbilicus ~ 2.5 mm wide; colour yellowish-brown. Protoconch ~ 2.3 mm in diameter, comprising 1.5 whorls, with weak, radially arranged pustulation. Teleoconch with fine, regularly and narrowly spaced radial ribs; inner umbilical whorls covered with fine periostracal pustules. Apertural lip sharp, weakly expanded and reflected, well rounded without nodes, parietal wall extremely delicate.

Genital anatomy (Figs. 199–200): Penis short and thin (shorter than vagina), with inflated distal end, complexly coiled within thick connective tissue. Epiphallus about same length, with very long, comparatively long epiphallic flagellum. Almost entire inner penial wall covered with large, irregular, roundish pustules that give rise to irregularly undulating, well-developed longitudinal pilasters at proximal third of interior wall. Inner epiphallic wall with two to three well-developed longitudinal pilasters. Penial retractor muscle about as long as penis. Vagina comparatively long, longer than free oviduct, tubular, inner wall with longitudinal pilasters. Free oviduct short, s-shaped. Bursa copulatrix with inflated head, extending anterior end of albumen gland. Spermoviduct and albumen gland typical.

Mitochondrial Differentiation

Intraspecific genetic distance (2 sequences): 0.0; interspecific genetic distances: 0.133–0.161 with respect to *T. girgarinae*, *T. aquilonia*, *T.*

flindersi, *T. freycineti*, *T. allouarni* and *T. tasmani*; 0.23–0.245 to all other congeners.

Comparative Remarks

Complex and tight coiling of penial complex within thick connective tissue, peculiar inner penial wall sculpture, long epiphallic flagellum and bursa copulatrix extending anterior end of albumen gland are typical features of this species.

Distribution (Fig. 160)

Known from Storr Island only.

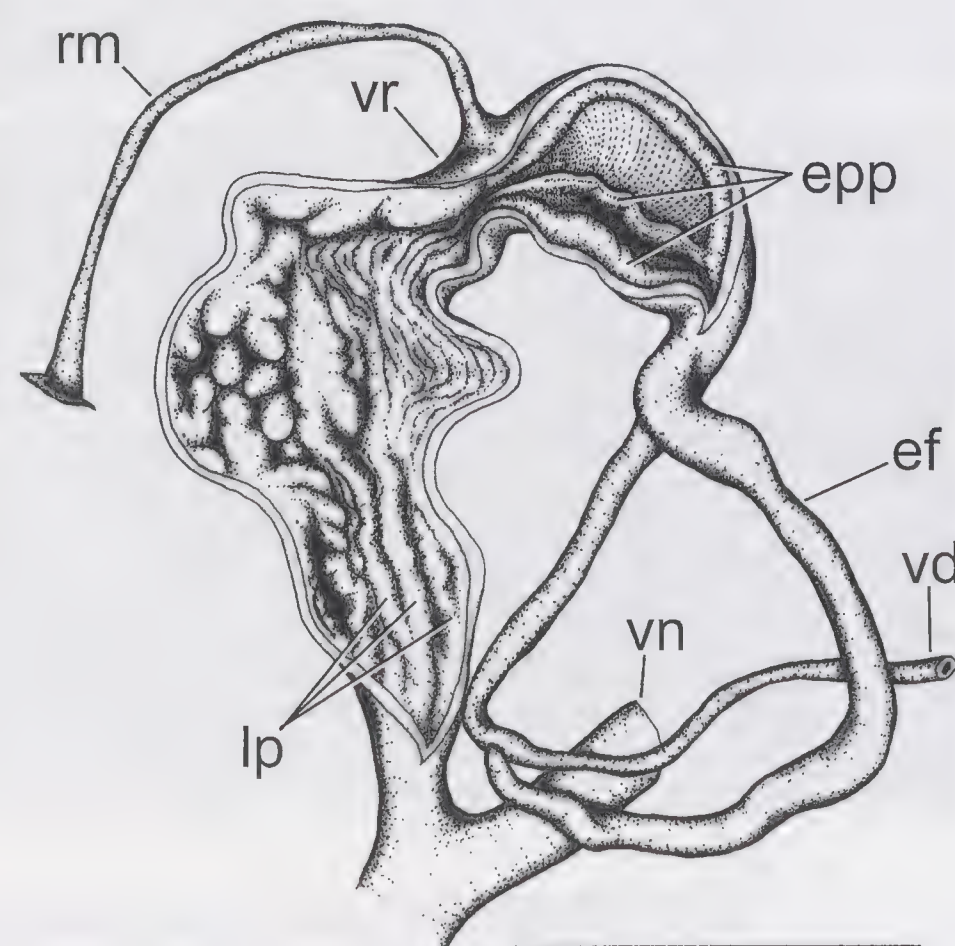


FIG. 200. Penial anatomy of *Torresitrachia leichhardti* n. sp. paratype AM C471791 (Storr Island, May). Scale bar = 3 mm.

***Torresitrachia hartogi* n. sp.**
Figs. 161P, 201–203

WAM S49261 (3 preserved specimens) from northern section of Molema Island.

Type Locality

Western Australia, southwestern Kimberley, Buccaneer Archipelago, Talbot Bay, N section of Molema Island, 16°15'09.7"S, 123°49'11.7"E; coll. Sean Stankowski, 27/05/2009, KIS 2–79 (rock scree in gully with vine thicket elements).

Etymology

Named in honour of Dirk Hartog, a Dutch explorer who in 1616 landed in Western Australia on what is now called Dirk Hartog Island; noun in genitive case.

Material Examined

Holotype WAM S58461 (preserved specimen, Fig. 161P). Paratypes WAM S37742 (22 preserved specimens), AM C471794 (10 preserved specimens), WAM S37868 (8 shells), AM C471795 (4 shells), WAM S37740 (4 preserved specimens), WAM S37867 (shell), WAM S37741 (9 preserved specimens), WAM S37743 (5 preserved specimens), WAM S37744 (preserved specimen), WAM S37869 (preserved specimen), WAM S49252 (3 shells),

Description

Shell (Figs. 161P, 201): Large ($D = 16.8\text{--}18.5$; Table 10), delicate and translucent, very broadly conical with weakly elevated spire; umbilicus ~ 2.5 mm wide; colour yellowish-brown, glossy. Protoconch ~ 3 mm in diameter, comprising about 1.5 whorls, with weak radial pustulation. Teleoconch with very fine, regularly and narrowly spaced radial ribs, becoming indistinct on base of shell; inner umbilical whorls covered with fine periostracal pustules; apertural lip sharp, well expanded, weakly reflected, well

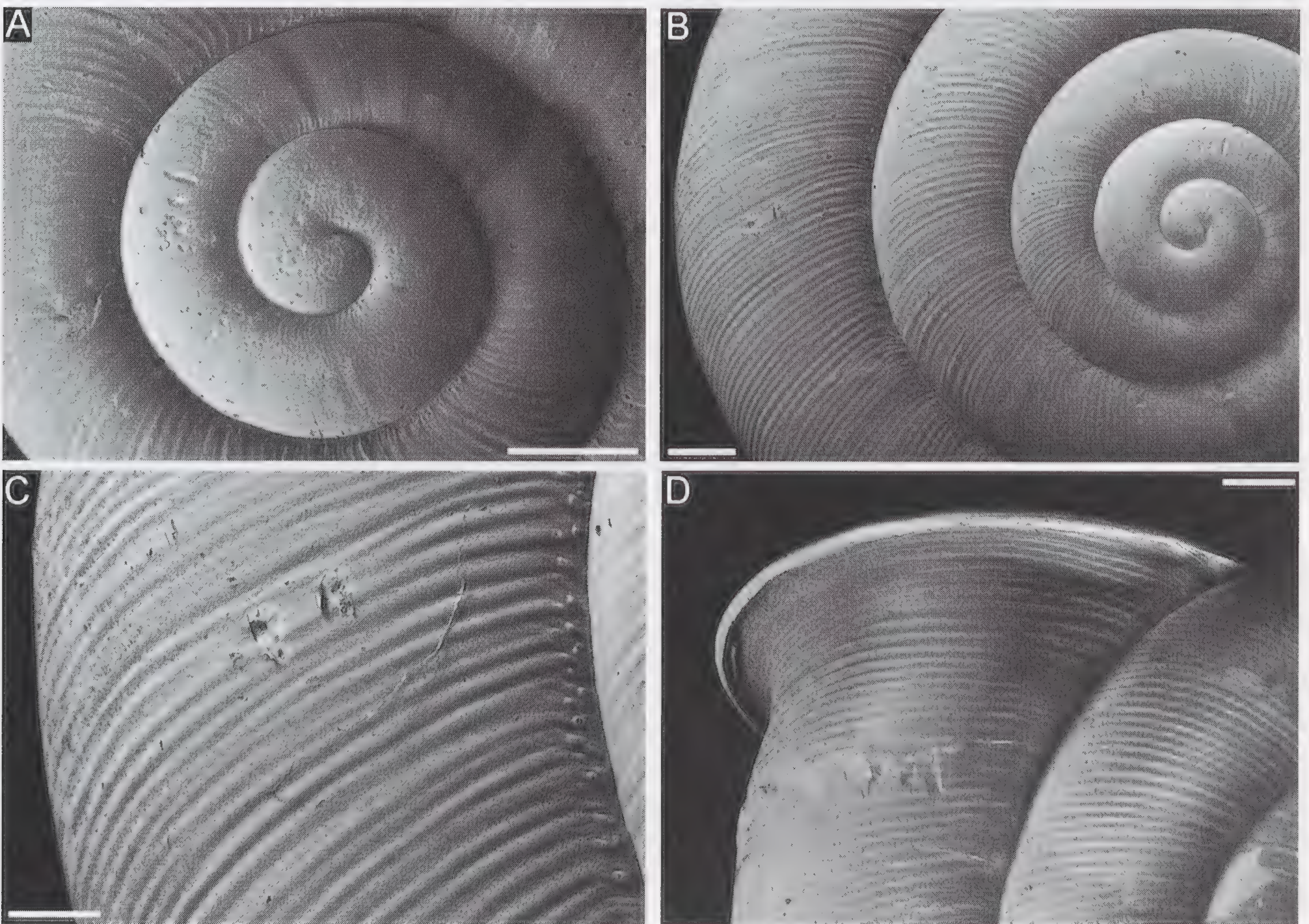


FIG. 201. SEM micrographs of the shell of *Torresitrachia hartogi* n. sp. paratype AM C471795 (Molema Island). A: Apical view showing protoconch and first whorl; B: Sculpture across entire shell viewed from above; C: Close-up of sculpture on last whorl; D: Sculpture on last whorl near aperture. Scale bars = A–B, D = 1 mm, C = 500 μm .

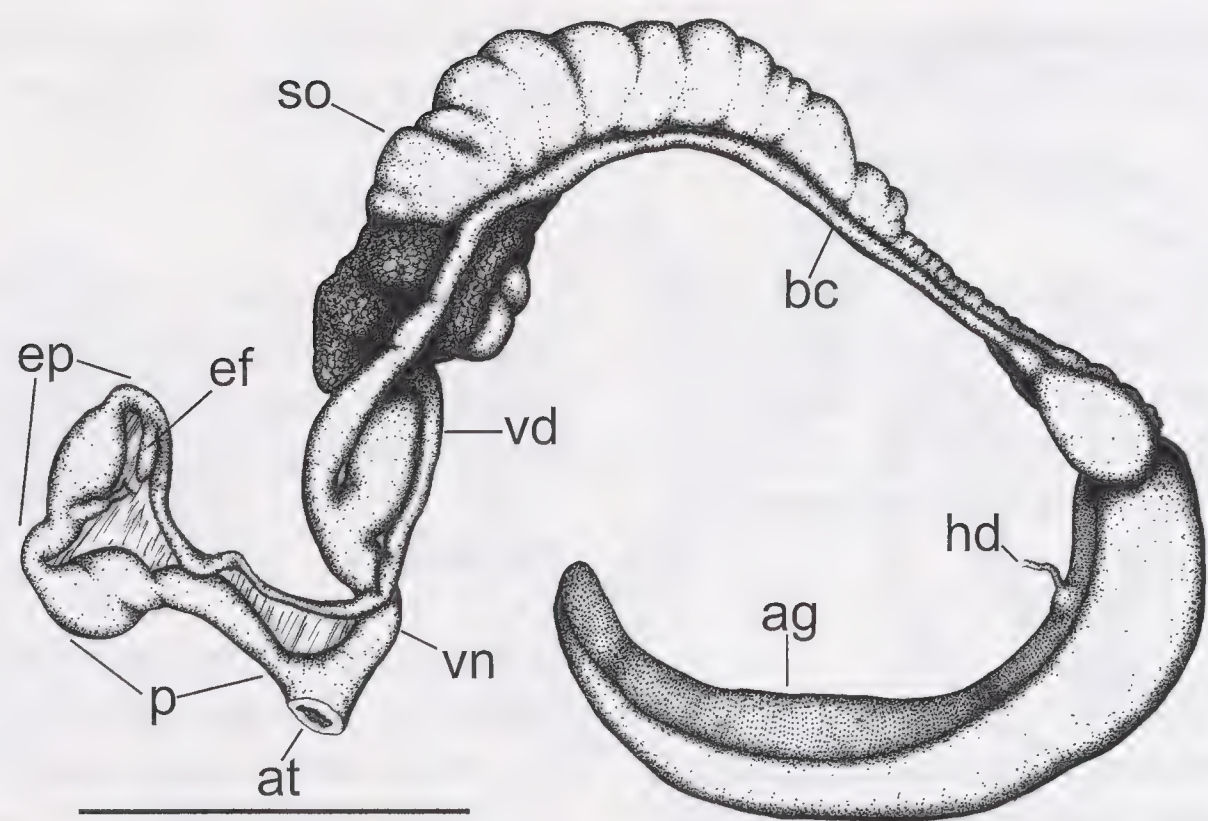


FIG. 202. Genital anatomy of *Torresitrachia hartogi* n. sp. para-type AM C471794 (Molema Island, May). Scale bar = 5 mm.

rounded without nodes, parietal wall extremely delicate.

Genital anatomy (Figs. 202–203): Penis short and thin (about same length as vagina), with inflated distal end, rather straight. Epiphallus shorter than penis, with short epiphallic flagellum. Distal third of inner penial wall with large,

irregular, roundish pustules, distal two thirds with three to four well-developed longitudinal pilasters. Inner epiphallic wall with well-developed longitudinal pilasters, wall in between these pilasters densely covered by minute pustules. Penial retractor muscle short. Vagina about same length as free oviduct, tubular. Free oviduct moderately long, rather straight. Bursa copulatrix with strongly inflated head, slightly extending anterior end of albumen gland.

Mitochondrial Differentiation

Intraspecific genetic distances (3 sequences): 0.001–0.025; interspecific distances 0.059–0.066 with respect to *T. girgarinae*, 0.106–0.152 to *T. allouarni*, *T. aquilonia*, *T. baudini*, *T. freycineti*, *T. leichhardtii* and *T. tasmani*; 0.199–226 to all other congeneric species.

Comparative Remarks

Very delicate, translucent and large shell is typical; axial sculpture of shell coarser than in *T. girgarinae* being the most closely related species as based on the low genetic distances. Characteristic features of the genital organs are irregularly sized, rounded pustules on penial wall, thick, densely covered with minute pustules in between pilasters of the epiphallic walls.

Distribution (Fig. 160)

Known from Molema Island, Talbot Bay only.

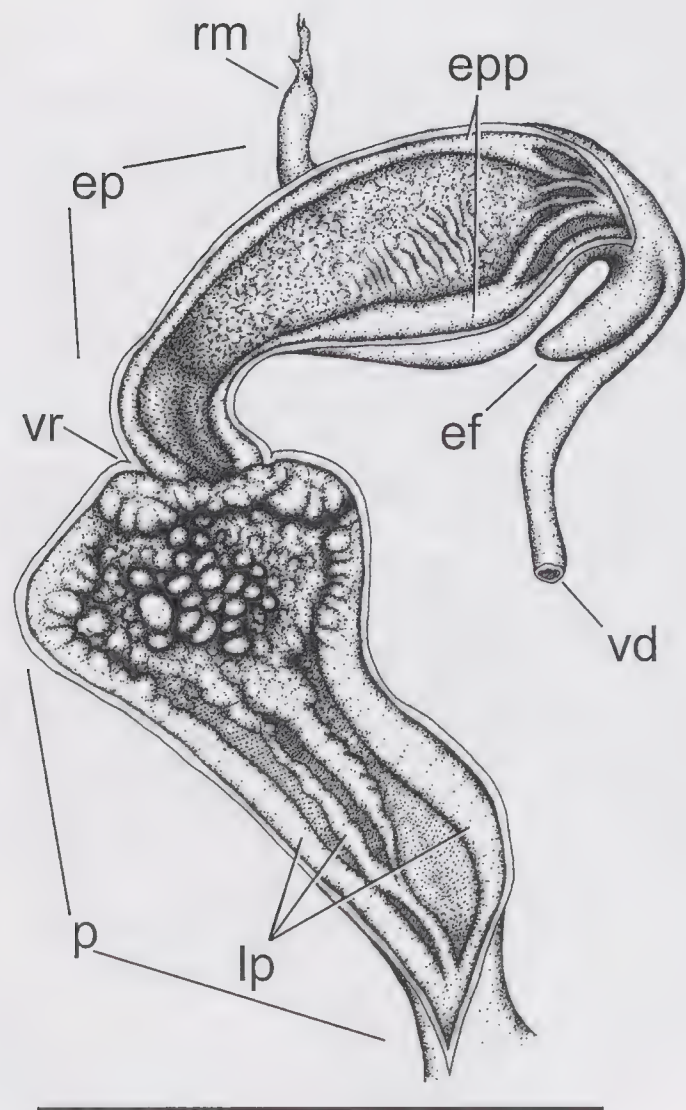


FIG. 203. Penial anatomy of *Torresitrachia hartogi* n. sp. paratype AM C471794 (Molema Island, May). Scale bar = 3 mm.

***Torresitrachia girgarinae* n. sp.**

Figs. 161Q, 204–206

Type Locality

Western Australia, southwestern Kimberley, Buccaneer Archipelago, NW section of Hidden Island, 16°13'29.3"S, 123°26'51.4"E, coll. Sean Stankowski, 06/06/2009, KIS 2–85 (aestivating between rocks in loose soil; free sealer).

Material Examined

Holotype WAM S37747 (preserved specimen, dissected). Paratypes WAM S37745 (3 preserved specimens), WAM S37746 (preserved specimen), WAM S37871 (2 shells, Fig. 161Q), WAM S37795 (preserved specimen), WAM S37870 (shell), AM C471800 (shell) from type locality.

Etymology

For Marie Louise Victoire Girgarin, a woman who sailed disguised as male on board the ship *La Recherche* under command of D'Entrecasteaux; noun in genitive case.

Description

Shell (Figs. 161Q, 204): Small to moderate in size ($D = 6.7$ mm on average; Table 10), discoidal to very broadly conical with low spire; periphery rounded to weakly angulated; umbilicus ~ 2.5 mm wide; colour light yellowish-brown, glossy. Protoconch ~ 2.2 mm in diameter, comprising about one whorl, essentially smooth. Teleoconch with very fine, regularly and narrowly spaced radial ribs, becoming indistinct on base of shell; inner umbilical whorls covered with fine periostracal pustules. Apertural lip sharp, weakly to well expanded,

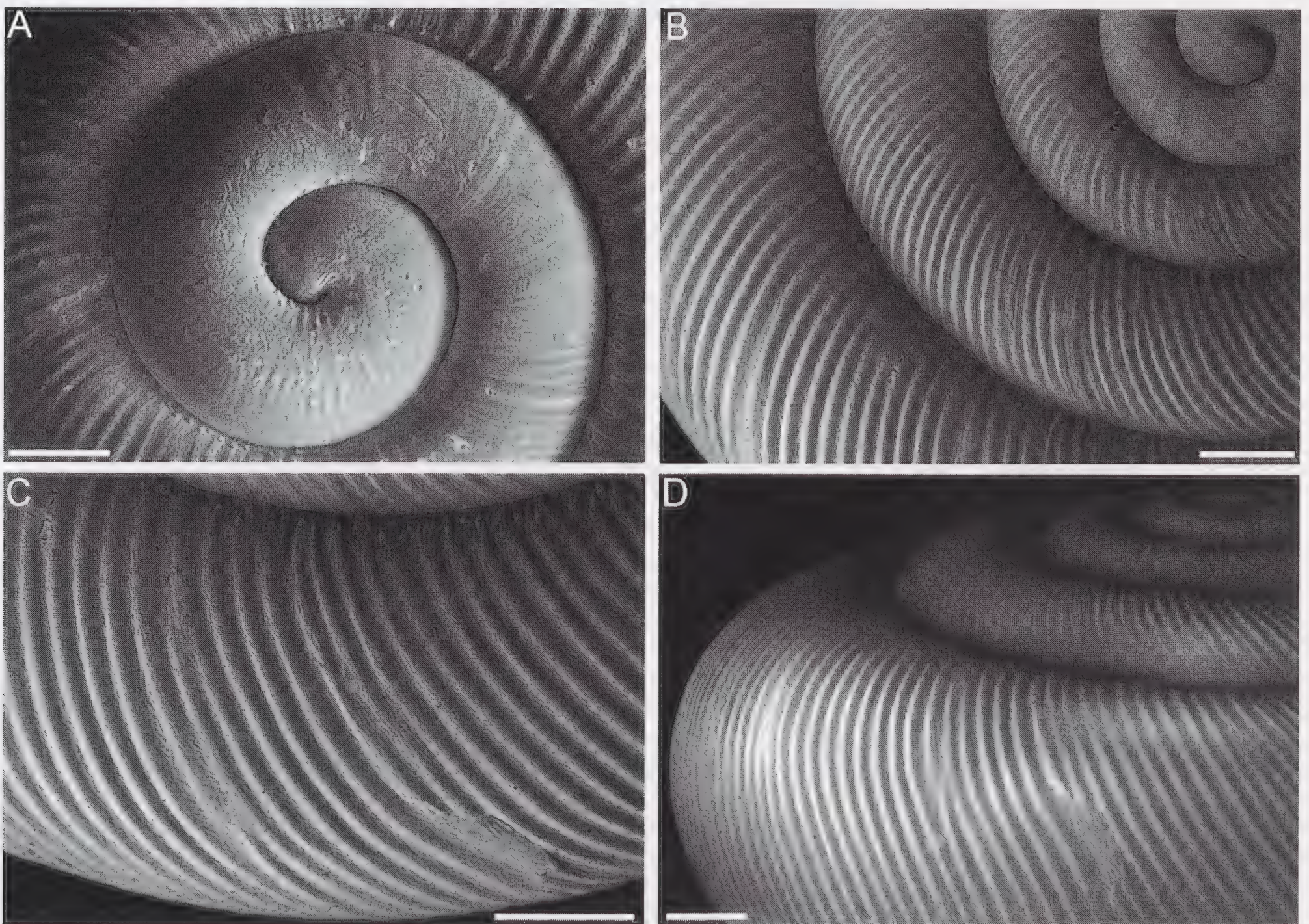


FIG. 204. SEM micrographs of the shell of *Torresitrachia girgarinae* n. sp. (Hidden Island). A: Holotype WAM S37747, apical view showing protoconch and first whorl. Scale bar = 500 µm; B–D: Paratype AM C471800. Scale bars = 1 mm. B: Sculpture across entire shell viewed from above; C: Close-up of sculpture on last whorl; D: Shell viewed obliquely from above, showing sculpture across whorls.

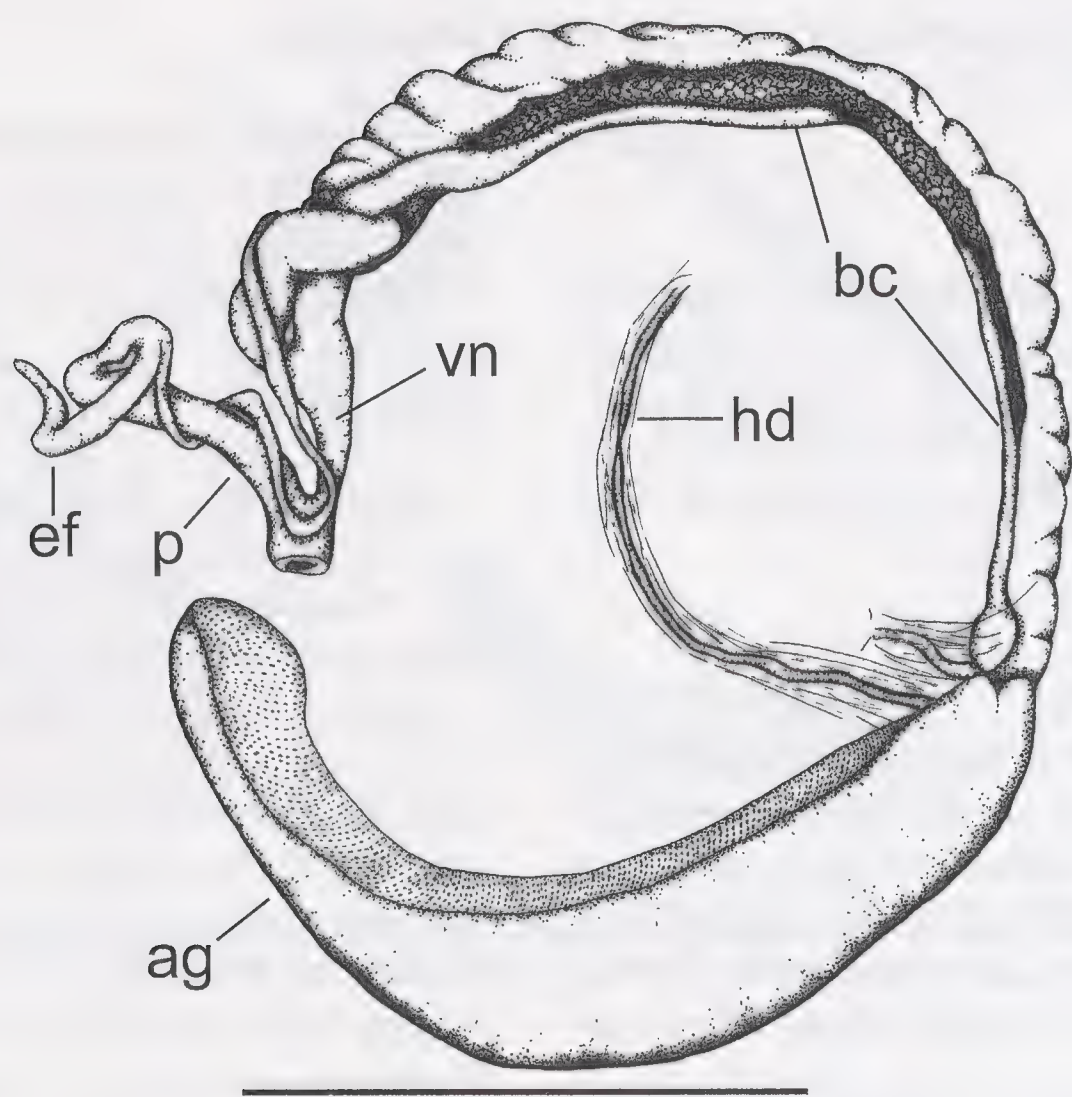


FIG. 205. Genital anatomy of *Torresitrachia girgarinae* n. sp. holotype WAM S37747 (Hidden Island, June). Scale bar = 5 mm.

weakly reflected, well rounded without nodes, parietal wall extremely delicate.

Genital anatomy (Figs. 205–206): Penis short, thin (about as long as vagina), rather straight. Epiphallus slightly shorter than penis, with comparatively long epiphallic flagellum.

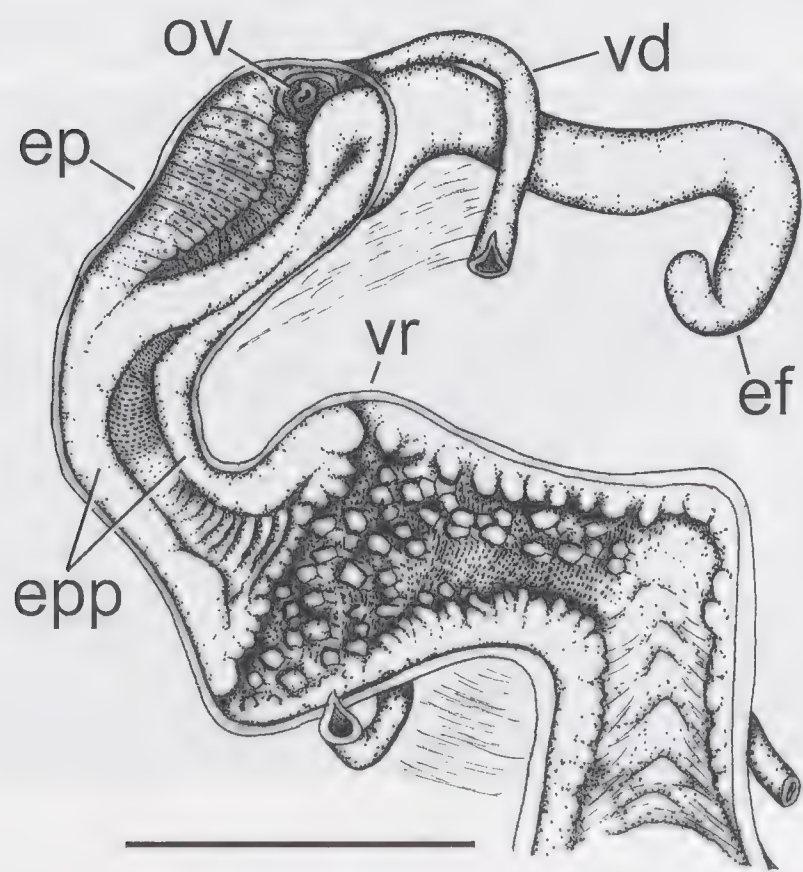


FIG. 206. Penial anatomy of *Torresitrachia girgarinae* n. sp. holotype WAM S37747 (Hidden Island, June). Scale bar = 1 mm.

Distal third of inner penial wall with sparsely distributed, small, roundish pustules that give rise to indistinct, corrugated pilasters at proximal end. Inner epiphallic wall with two thick longitudinal pilasters, near opening to vas deferens an additional, corrugated pilaster. Penial retractor muscle short. Vagina about same length as free oviduct, tubular. Free oviduct short, coiled. Bursa copulatrix with slightly inflated head, reaching anterior end of albumen gland.

Mitochondrial Differentiation

Intraspecific genetic distance (3 sequences): 0.0–0.006; interspecific genetic distances: 0.059–0.063 with respect to *T. hartogi*, 0.110–0.161 to *T. aquilonia*, *T. allouarni*, *T. flindersi*, *T. freycineti*, *T. leichhardti* and *T. tasmani*; 0.229–0.236 to all other congeners.

Comparative Remarks

Genetically closest and most similar species is *T. hartogi*, which differs by coarser shell sculpture, larger shell size, and details of penial and epiphallic wall sculpture.

Distribution

Buccaneer Archipelago, Hidden Island.

Kimberleytrachia n. gen.

Description

Torresitrachia – Solem, 1979: 45–92 (partim); 1985a: 922–933 (partim); 1991: 178–185 (partim), Solem & McKenzie, 1991: 247–263 (partim).

Type species

Kimberleytrachia somniator n. sp.

Etymology

Derived from the words “Kimberley” (the region in Western Australia, where this group occurs) and the Latin word “trachea” (= windpipe, from Greek “trachea”). The suffix “-trachea” has been employed in several Australian camaenids, probably for the resemblance of radial ribs on shells with annular bands of cartilage that reinforce the windpipe of mammals. Species of the present genus lack axial ribbing but the term is employed nevertheless in continuation of the tradition to use this suffix for Australian camaenids and in distinction to “*Torresitrachia*”, the name under which some of its members were previously subsumed; noun of feminine gender.

Shell: Medium sized (D = 12–24 mm; Table 11), thin or mostly very delicate, discoidal to broadly conical with flat to moderately elevated spire; umbilicus narrowly open, may be partly concealed; protoconch with crowded pustules arranged in radial pattern; teleoconch lacking strongly developed radial ribs (faint radial growth lines may be present), with well-developed microsculpture of periostracal setae or projections (particularly visible in juvenile shells); whorls moderately to slowly increasing, separated by deep suture, periphery well rounded. Shell colour light to yellowish brown, no colour banding. Aperture wide, with relatively thin, weakly to moderately expanded and weakly reflected lip, palatal node absent, basal node weak or absent, parietal wall inconspicuous.

Radula: 2–5 mm long; C + 12–20 + 2–4 + 14–22.

Genital anatomy: Penis without penial sheath, embedded in connective tissue; epiphallus well developed, with well-developed epiphallic flagellum. Inner penial wall supporting simple to rather complex armature of longitudinal, oblique or transverse pilasters or lamellae, frequently with

TABLE 11. Shell parameters of *Kimberleytrachia* (in mm), given are maximum – minimum (mean ± standard deviation) for N measured specimens. Abbreviations used: HT = holotype.

Species	N	Height (H)	Diameter (D)	Umbilical Width	Whorls	H/D Ratio
<i>K. somniator</i> n. sp.	HT	13.0	22.2	2.0	4.5	0.59
	6	10.0–13.6	18.5–22.5	2.0–3.0	4.1–4.8	0.50–0.61
		(12.2 ± 1.2)	(21.6 ± 1.3)	(2.5 ± 0.4)	(4.4 ± 0.2)	(0.57 ± 0.03)
<i>K. canopi</i> n. sp.	HT	11.8	23.6	3.5	5.2	0.50
<i>K. alphacentauri</i> n. sp.	HT	6.8	12.9	concealed	4.0	0.53
	17	5.6–7.5	10.8–14.2	concealed	3.4–4.0	0.49–0.60
		(6.4 ± 0.5)	(12.4 ± 0.8)		(3.7 ± 0.2)	(0.52 ± 0.03)
<i>K. chartacea</i> n. sp.	HT	10.0	21.1	3.0	4.0	0.47
	10	9.7–11.2	18.8–22.0	0–3.5	4.0–4.7	0.46–0.55
		(10.3 ± 0.4)	(21.0 ± 0.9)		(4.4 ± 0.2)	(0.49 ± 0.03)
<i>K. amplirhagadoides</i> n. sp.	HT	14.6	21.0	2.0	4.9	0.70
	5	12.0–14.6	19.5–21.1	0–2.0	4.3–4.9	0.62–0.70
		(13.4 ± 0.9)	(20.4 ± 0.6)		(4.6 ± 0.2)	(0.65 ± 0.03)
<i>K. achernaria</i> n. sp.	HT	12.0	20.5	concealed	4.3	0.59
	10	11.4–13.5	20.5–22.2	0–2.7	4.3–4.7	0.55–0.63
		(12.6 ± 0.6)	(21.4 ± 0.6)		(4.5 ± 0.1)	(0.59 ± 0.02)
<i>K. crawfordi</i>	6	12.1–13.3	21.0–23.1	2.7–3.2	4.7–5.0	0.56–0.62
		(12.8 ± 0.4)	(22.0 ± 0.8)	(2.9 ± 0.2)	(4.9 ± 0.1)	(0.58 ± 0.02)

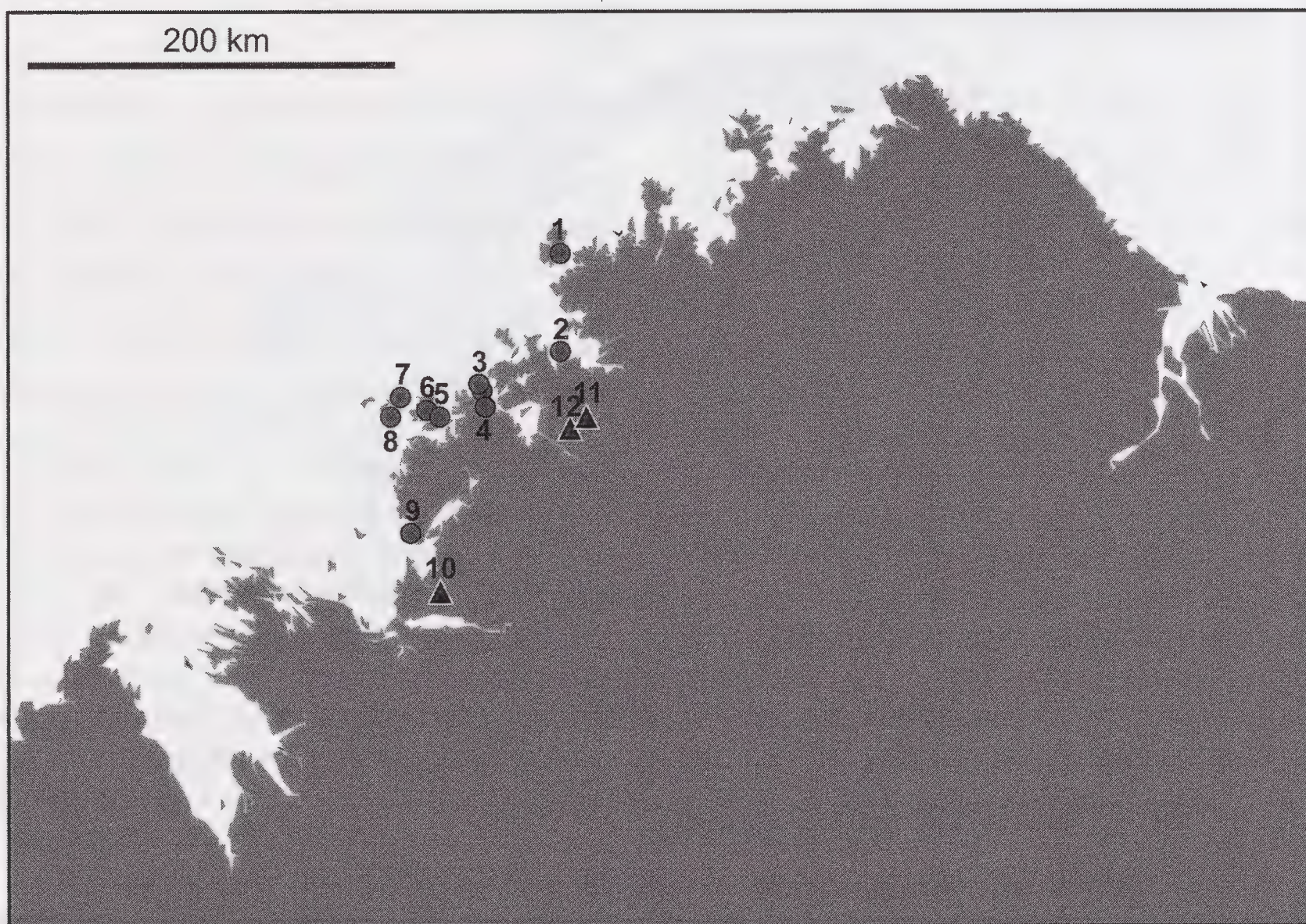


FIG. 207. Distribution map of *Kimberleytrachia* n. gen. Circles = records of species treated herein: 1: *K. somniator* n. sp. (Bigge Island), 2: *K. alphacentauri* n. sp., *K. aequum* n. sp., *K. canopi* n. sp. (Boongaree Island), 3: *K. chartacea* n. sp. (Uwins and Mictyis Islands), 4: *K. hirsuta* n. sp. (1.3 km S of Halfway Bay), 5: *K. achernaria* n. sp. (SE Augustus Island), 6: *K. amplirhagadoides* n. sp. (NW Augustus Island), 7: *K. crucis* n. sp. (D'Arcy Island), 9: *K. crawfordi* (Storr Island); triangles = records listed by Solem (1979, 1985a, 1991), 10: *K. crawfordi* (SW Doubtful Bay, N of Walcott Island), 11: *K. umbonis* (Prince Regent Reserve), 12: *K. deflecta* (Prince Regent Reserve).

pad-like swelling underneath opening to epiphallus, pustulation, lateral lamellae or more complex armature may be present. Penial retractor muscle attached at epiphallus between mid-portion to near posterior end. Epiphallus opens to penial lumen through constricting circular vergic ring. Inner epiphallic wall supporting longitudinal pilasters that vary in number and development. Vas deferens rather thin, entering epiphallus laterally near distal end or terminally through slit-like opening or often hose-like extended into lumen of epiphallus. Bursa copulatrix elongate, tubular, reaching anterior end of albumen gland.

Aestivation Strategy

Rock sealer.

Comparative Remarks

Species of this group were subsumed under the genus *Torresitrachia* for their somewhat similar shell shape and generally similar genital anatomy. However, both genera form

distinct monophyla in phylogenetic trees of the Camaenidae (Köhler, 2009, 2010c). Shells of *Kimberleytrachia* differ by being much thinner, larger, lack of axial ribs, presence of periostracal setae (which are found in some *Torresitrachia* species as well), and more pronouncedly descending body whorl. Genitalia of *Kimberleytrachia* differ most conspicuously by different anatomy of inner penial wall. Species of *Torresitrachia* always exhibit a combination of distal pustulation and longitudinal pilasters in proximal part of penial wall whereas *Kimberleytrachia* is characterised by absence of regularly arranged, rhomboid pustules but mostly has oblique or lateral lamellae or pilasters instead. Vas deferens of *Torresitrachia* entering epiphallus terminally, while in *Kimberleytrachia* it enters laterally (even if often close to distal end), often as a hose-like structure. In addition, *Torresitrachia* species are free sealers while *Kimberleytrachia* species are rock sealers.

Based on these differentiating features, the following species are herein transferred from *Torresitrachia* to *Kimberleytrachia*: *K. umbo-*

nis (Solem, 1979), *K. crawfordi* (Solem, 1979) and *K. deflecta* (Solem, 1985).

Diversity and Distribution (Fig. 207)

In addition to three species described by Solem (1979, 1985a) from Prince Regent Reserve and Doubtful Bay, nine species are described here from islands along the Kimberley coast between Bigge Island in the north and Doubtful Bay in the south.

***Kimberleytrachia somniator* n. sp.**

Figs. 208A, 209–211

Type Locality

Western Australia, northwestern Kimberley, Bonaparte Archipelago, W coast of Bigge Island, base of slopes on E side of a small creek valley, south of Boomerang Bay, 14°35'00"S,

125°06'10"E; coll. Vince Kessner, 16/02/2008, KIS 1–38 (W-facing sandstone slopes, overhangs, talus; live under overhanging sandstone slab).

Material Examined

Holotype WAM S36867 (preserved specimen, dissected, Fig. 208A). Paratypes WAM S58464 (preserved specimen) from type locality; WAM S36411 (2 shells) from 14°35'16"S, 125°11'06"E; AM C471808 (shell), WAM S36412 (2 shells) from 14°35'33"S, 125°11'19"E; WAM S36413 (2 shells) from 14°35'06"S, 125°06'12"E; AM C471809 (shell), WAM S36415 (shell) from 14°35'07"S, 125°05'56"E; WAM S36416 (shell) from 14°35'12"S, 125°06'13"E; WAM S36417 (shell) from 14°34'46"S, 125°05'55"E; WAM S36758 (2 shells) from 14°35'06"S, 125°06'12"E; WAM S36970 (shell) from 14°35'32"S, 125°06'19"E.

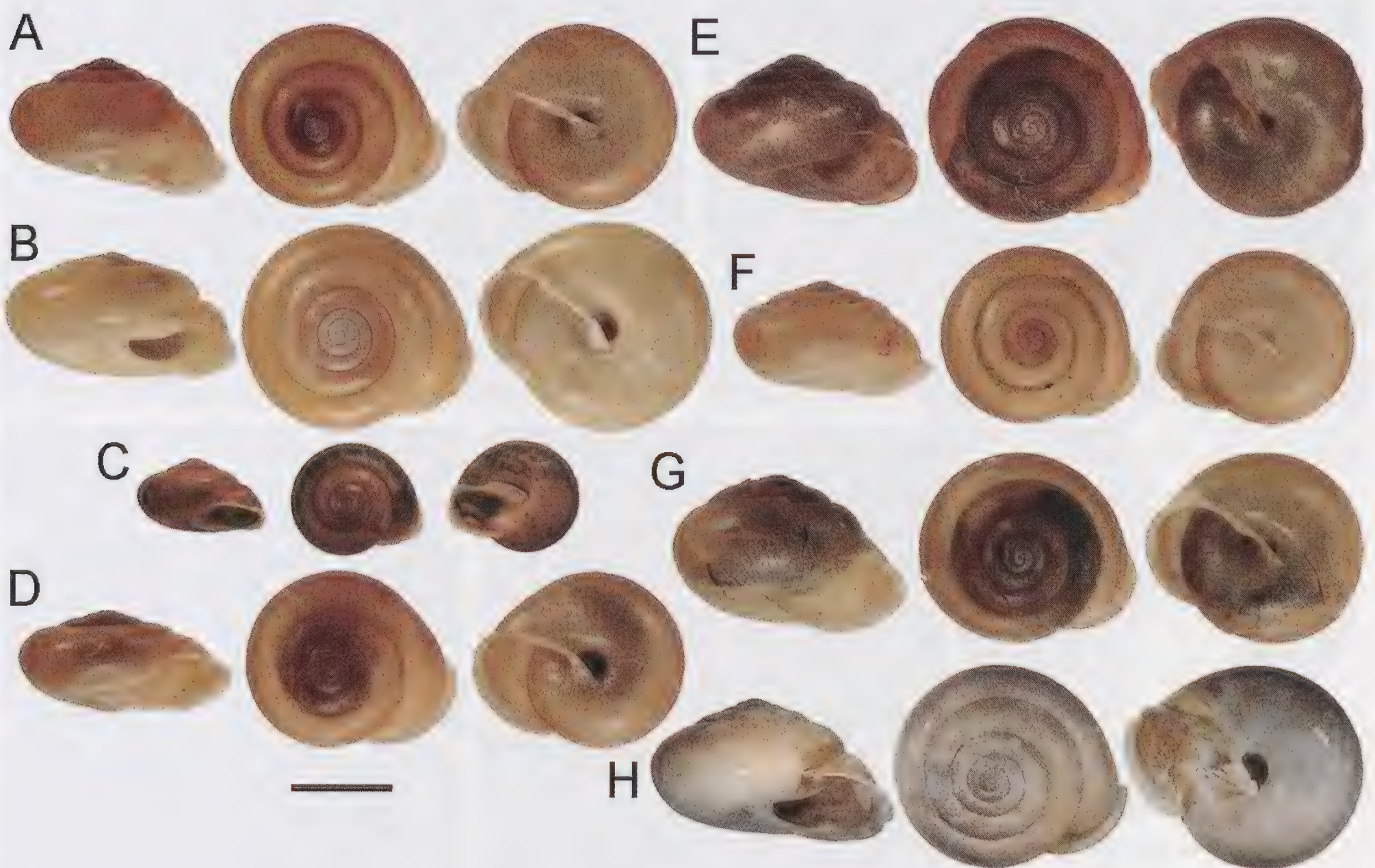


FIG. 208. Shells of *Kimberleytrachia* species. A: *Kimberleytrachia somniator* n. sp. holotype WAM S36867 (Bigge Island); B: *Kimberleytrachia canopi* n. sp. holotype WAM S49017 (Boongaree Island); C: *Kimberleytrachia alphacentauri* n. sp. holotype WAM S58465 (Boongaree Island); D: *Kimberleytrachia chartacea* n. sp. holotype WAM S58466 (Uwins Island); E: *Kimberleytrachia amplirhagadoides* n. sp. holotype WAM S58467 (Augustus Island, NW section); F: *Kimberleytrachia achernaria* n. sp. holotype WAM S58468 (Augustus Island, SE section); G: *Kimberleytrachia crucis* n. sp. holotype WAM S58469 (D'Arcy Island); H: *Kimberleytrachia crawfordi* WAM S58469 (Storr Island). Scale bar = 10 mm. Note that due to their transparency empty shells and look very different from those that contain animal; foot protrudes from shell of *K. alphacentauri*.

Etymology

For “*somniator*” (Latin = dreamer, also a person who puts faith in dreams), referring to Dreaming as foundation of Indigenous culture and spiritual beliefs; noun in apposition.

Description

Shell (Figs. 208A, 209A–D): Moderate in size ($D = 18.5\text{--}22.5\text{ mm}$; Table 11), delicate, broadly conical with low or moderately elevated spire; periphery well rounded to slightly

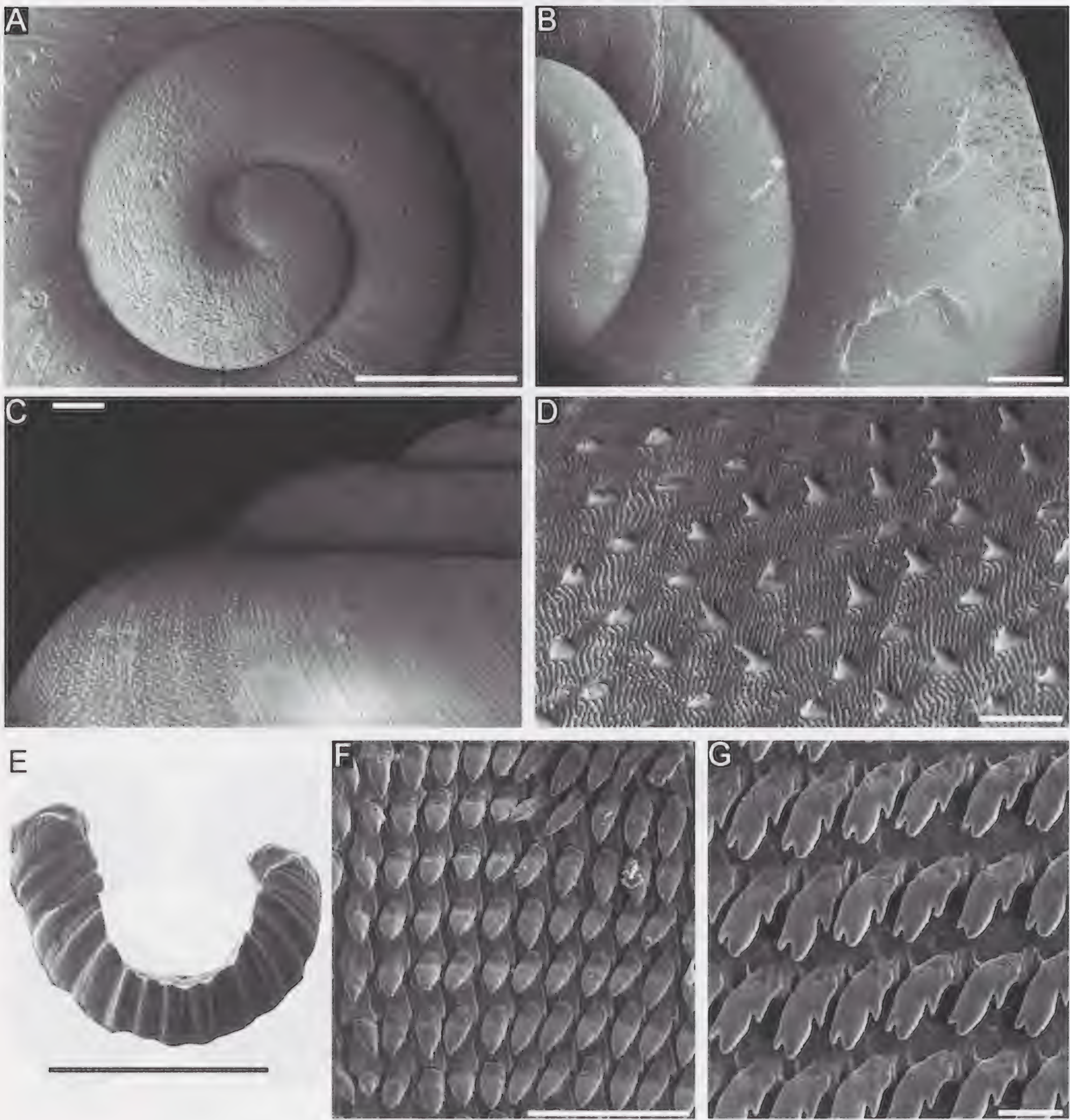


FIG. 209. SEM micrographs of *Kimberleytrachia somniator* n. sp. (Bigge Island). A–D: Shell paratype AM C471809. A: Apical view showing protoconch; B: Sculpture across entire shell viewed from above; C: Lateral view of last whorls. Scale bars A–C = 1 mm; D: Close-up of micro-sculpture on last whorl. Scale bar = 100 μm ; E: Jaw holotype WAM S36867. Scale bar = 1 mm; F–G: Radula holotype WAM S36867. F: Central and lateral teeth viewed from above. Scale bar = 100 μm ; G: Middle marginal teeth viewed obliquely from above. Scale bar = 20 μm .

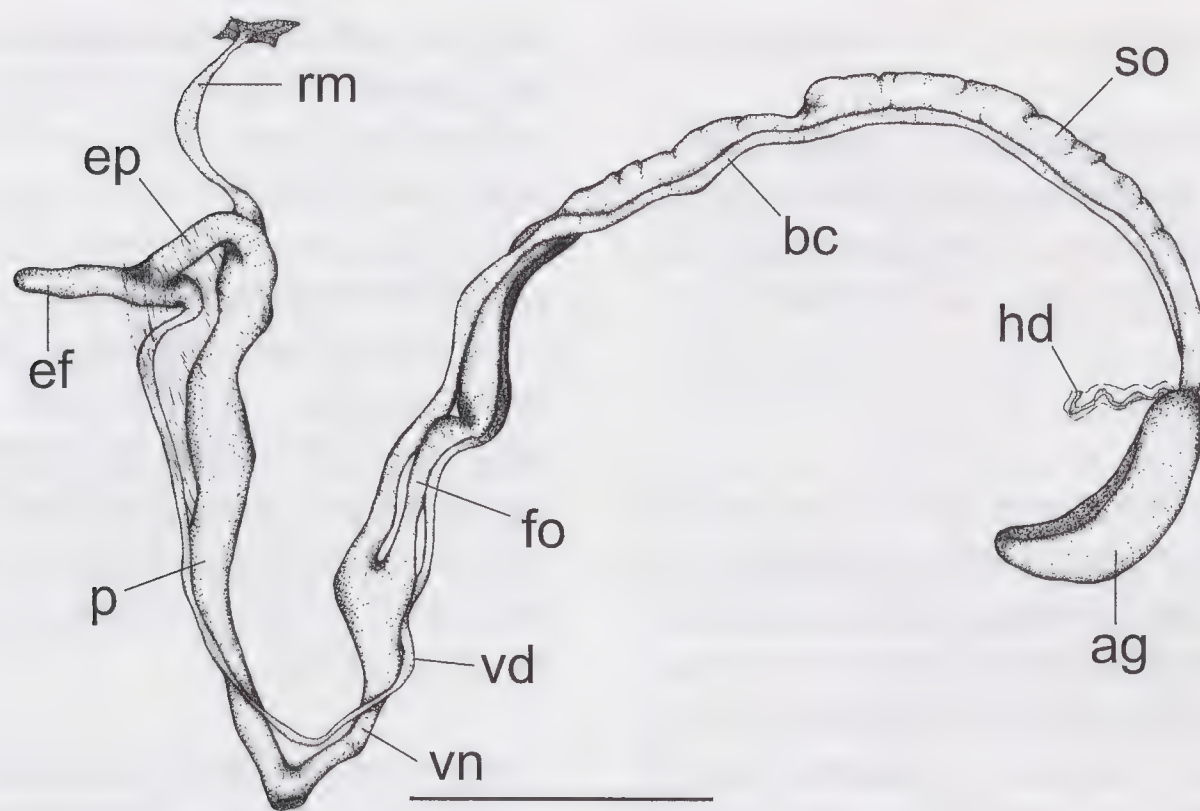


FIG. 210. Genital anatomy of *Kimberleytrachia somniator* n. sp. holotype WAM S36867 (Bigge Island, February). Scale bar = 5 mm.

angulated; umbilicus 1–3 mm wide, 30–90% concealed; colour amber, base of shell lighter, pale yellowish-horn. Protoconch ~ 2.4 mm in diameter, comprising 1–1.5 whorls, with very fine pustulation. Teleoconch smooth, with faint radial growth lines only; densely covered with fine periostracal setae, regularly arranged in radial pattern; microsculpture worn out in older shells giving them a glossy shine; inner umbilical whorls with well-developed pustules. Angle of aperture 30–45°; wide, simple, inside whitish, with moderately to strongly expanded, weakly reflected, thin lip; palatal node absent, basal node weakly developed.

Digestive anatomy (Fig. 211E–G): Jaw consisting of about 15 plates. Radula C + 14–16 + 3–4 + 14–18.

Genital anatomy (Figs. 210–211): Penis elongate, much longer than vagina. Inner penial wall with fine and densely packed lateral lamellae at distal end, which gradually transform into oblique pilasters at proximal end, some isolated pustules present at lateral ends of lamellae in mid-portion of inner penial wall. Epiphallus bent, attached to penis by connective tissue; much shorter than penis, with well-developed epiphallic flagellum (almost as long as epiphallus); inner epiphallic wall supporting complex of delicate longitudinal pilasters along its entire length, some of them reaching into flagellum, distal end of inner epiphallic wall supports very fine lateral lamellae in continuation of armature of penial wall. Penial retractor muscle moderately long. Vas deferens rather thin. Vagina shorter than free oviduct.

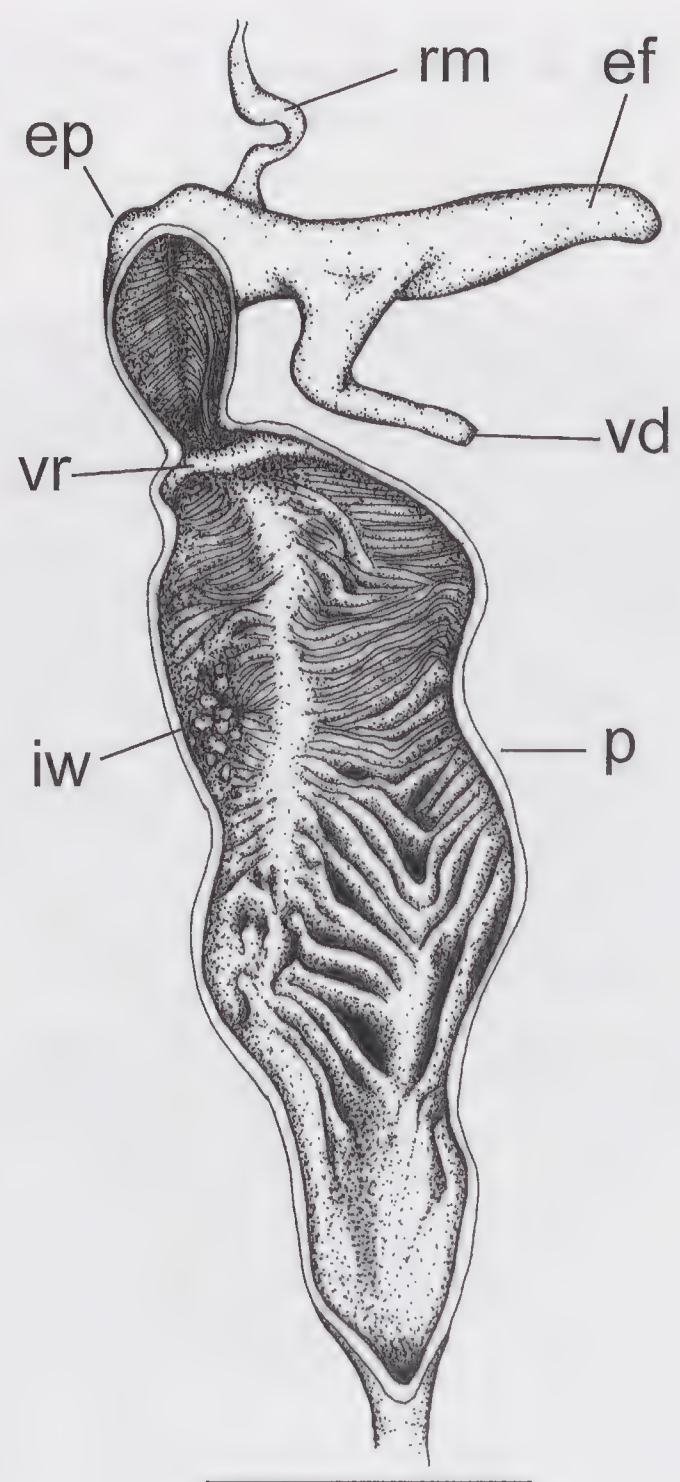


FIG. 211. Penial anatomy of *Kimberleytrachia somniator* n. sp. holotype WAM S36867 (Bigge Island, February). Scale bar = 2 mm.

Mitochondrial Differentiation

Interspecific genetic distances (1 sequence): 0.070–0.075 to *K. chartacea* (5 sequences), 0.272 to *K. crawfordi* from Storr Island, 0.093–0.105 to all other congeneric sequences.

Comparative Remarks

Shell similar to *K. umbonis* from Prince Regent Reserve; which differs most conspicuously by inner penial wall sculpture of well-developed, densely packed longitudinal pilasters at proximal end of wall distally being replaced by very fine and densely and regularly spaced lateral lamellae comprising about 80% of entire length of penial wall.

Distribution (Fig. 207)

Bigge Island.

Kimberleytrachia umbonis (Solem, 1979)
n. comb.

Torresitrachia umbonis Solem, 1979: 87–91,
pl. 4a–d, 7a–c, figs. 17e, f, 18a.

Type Locality

Western Australia, northwestern Kimberley, Prince Regent Reserve, Enid Falls, Rufous Creek (Fig. 207).

Taxonomic Remarks

Solem (1979) introduced this name for a species from the Prince Regent Reserve. Solem (1985a) considered specimens from the Mitchell Plateau as conspecific, which was subsequently refuted by Solem (1991), who stated that these were outside of the range of this species. Solem (1991) stated that the range of *K. umbonis* extends southward into the Saint George Basin area. This claim requires confirmation by comparative study of the anatomy. Although exhibiting a similar shell, species from various islands treated below are not conspecific with *K. umbonis* as evidenced by their distinct genital anatomy. Here placed in *Kimberleytrachia* for exhibiting typical characteristics of shell and genitalia.

Diagnosis

Shell: Large ($D = 20.4$ on average), broadly

conical with moderately elevated spire, slightly angulated periphery, umbilicus almost entirely concealed; teleoconch with fine, widely spaced pustules joined by weak radial ridges, radial ribs becoming more prominent on third whorl; body whorl sharply descending.

Genital anatomy: Inner penial wall sculptured with regular, dense, well-developed circular ridges, anteriorly gradually dissolving into longitudinal pilasters. Epiphallus shorter than penis, with short flagellum; inner epiphallic wall with longitudinal pilasters (adapted from Solem, 1979).

Kimberleytrachia deflecta (Solem, 1985)
n. comb.

Torresitrachia deflecta Solem, 1985a: 925–930,
pl. 93a–d, 94a–e, figs. 236a–c, 237a–c.

Type Locality

Western Australia, northwestern Kimberley, Upper Prince Regent Reserve, valley of the Youwanjela Creek (Fig. 207).

Taxonomic Remarks

Solem (1985a) introduced this name for a species from the Upper Prince Regent Reserve. Solem (1991) stated that it ranges from Prince Fredrick Harbour in the north to the Saint George Basin in the south, which requires confirmation by comparative study of the anatomy. Here placed in *Kimberleytrachia* for exhibiting typical characteristics of the inner penial wall.

Diagnosis

Shell: Small ($D = 12.6$ on average), broadly conical with moderately elevated spire, weakly angulated periphery, umbilicus partly concealed; teleoconch with fine, widely spaced, radially elongated ridglets plus microsculpture of fine periostracal ridglets; body whorl sharply descending.

Genital anatomy: Inner penial with complex sculpture of intersecting longitudinal pilasters on anterior two thirds giving rise to fishbone-pattern of V-shaped rather horizontal pilasters on distal third. Epiphallus as long as penis, with short flagellum; inner epiphallic wall with many, densely packed, delicate longitudinal pilasters (adapted from Solem, 1985a).

***Kimberleytrachia canopi* n. sp.**
Figs. 208B, 212–214

Description

Shell (Figs. 208B, 212): Large ($D = 23$ mm), delicate, broadly conical with rather low spire; periphery slightly angulated, upper sector of whorls well rounded, whorls separated by deeply incised suture; umbilicus narrowly open, 3.5 mm wide, 30% concealed; colour amber, base of shell lighter, pale yellowish-horn. Protoconch ~ 2.7 mm in diameter, comprising one whorl, almost smooth. Teleoconch with well-developed radial growth lines; microsculpture of sparsely distributed periostracal setae worn in adult shells; inner umbilical whorl with some pustules. Last whorl strongly descending behind aperture; angle of aperture 30° ; wide, simple, with moderately to strongly expanded, weakly reflected, thin lip; palatal node absent, basal node well developed.

Genital anatomy (Figs. 213–214): Penis elongate, about same length as vagina. Inner penial wall with well-developed longitudinal pilasters at proximal half; pilasters becoming corrugated towards distal end of wall, ultimately dissolving into complex structure of undulating lamellae

Type Locality

Western Australia, northwestern Kimberley, Bonaparte Archipelago, central section of Boongaree Island, $15^\circ 04' 19''$ S, $125^\circ 11' 18''$ E; coll. Vince Kessner, 07/02/2009, KIS 1–65 (vine thicket/rainforest on steep upper slopes, large boulders; active on trees at night after rain).

Material Examined

Holotype WAM S49017 (shell, Fig. 208B), WAM S29306 (body of the same individual).

Etymology

For the name of the brightest star in the southern constellation Carina and Nova Artis, Canopus. Until the invention of the magnetic compass, this bright star was important for navigation and served as a southern pole star, noun in genitive case.

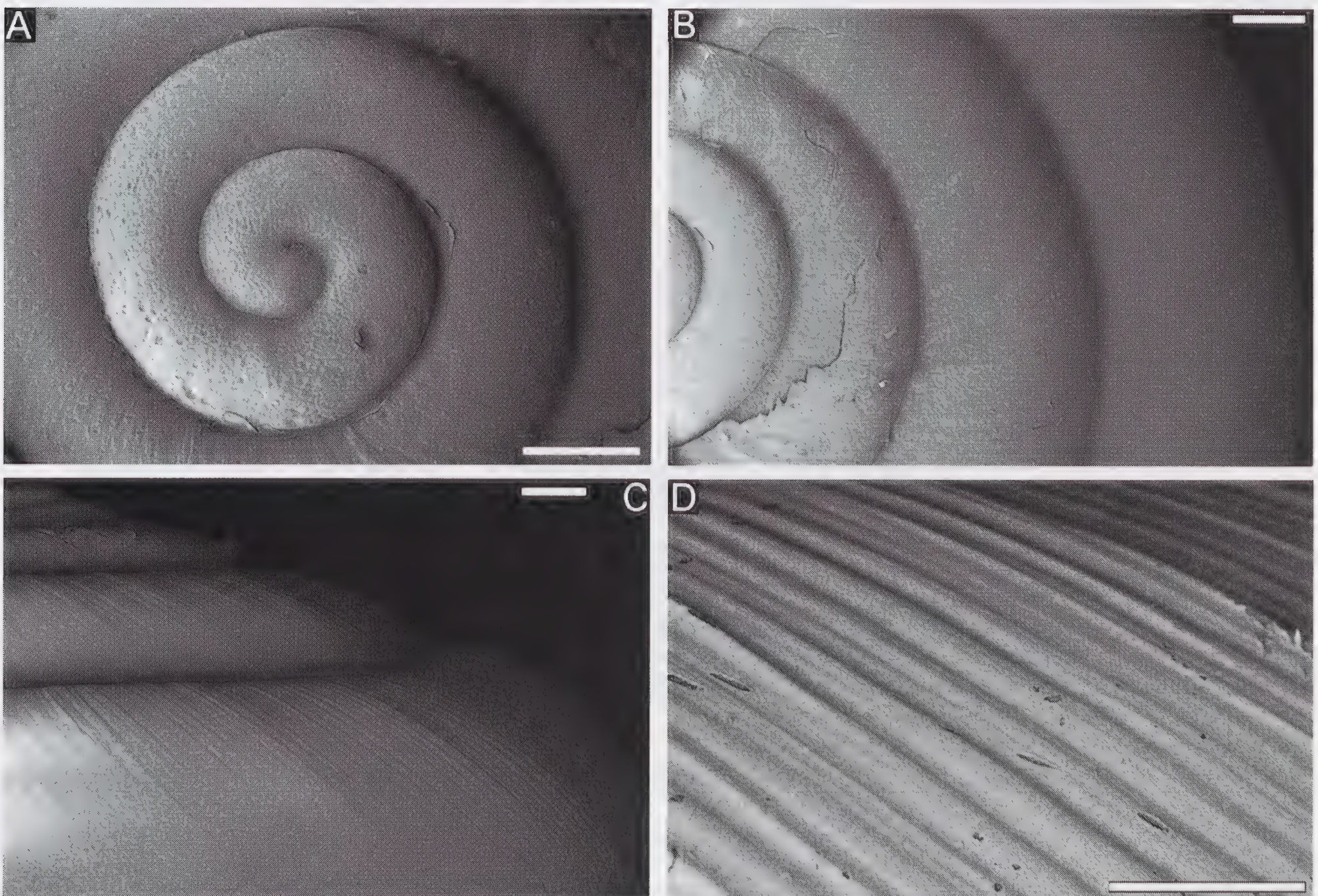


FIG. 212. SEM micrographs of the shell of *Kimberleytrachia canopi* n. sp. holotype WAM S49017 (Boongaree Island). A: Apical view showing protoconch and first whorl; B: Sculpture across entire shell viewed from above; C: Lateral view of last whorls. Scale bars A–C = 1 mm; D: Close-up of microsculpture on last whorl. Scale bar = 500 μ m.

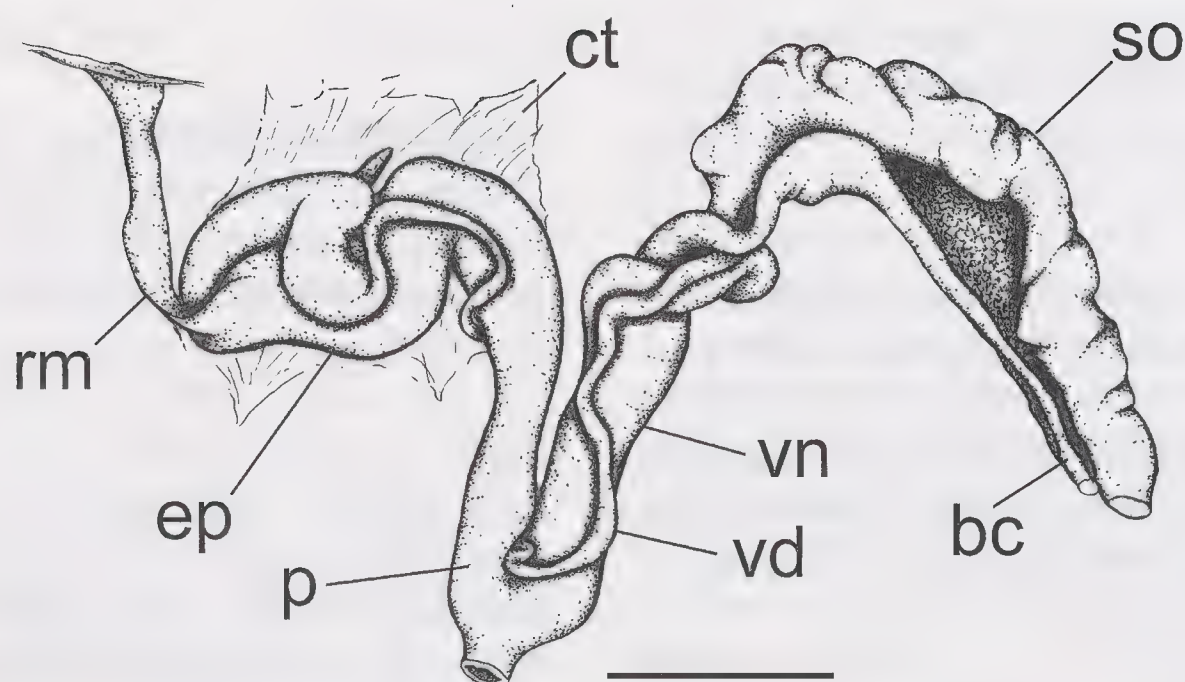


FIG. 213. Genital anatomy of *Kimberleytrachia canopi* n. sp. holotype WAM S29306 (Boongaree Island, February). Note that distal parts of spermatheca, bursa copulatrix and albumen gland are lacking. Scale bar = 5 mm.

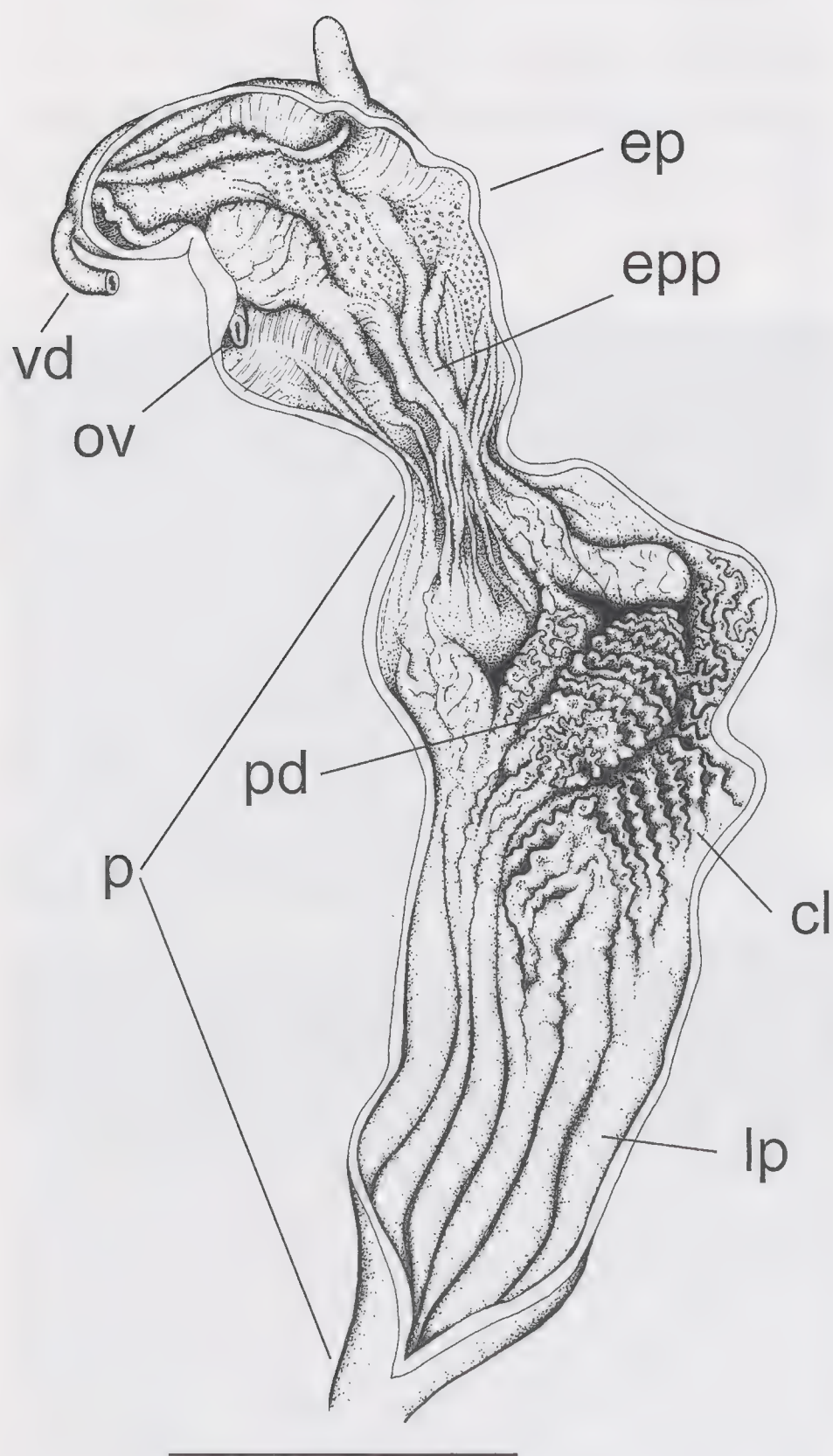


FIG. 214. Penial anatomy of *Kimberleytrachia canopi* n. sp. holotype WAM S29306 (Boongaree Island, February). Scale bar = 5 mm.

and partly elongated pustules that are arranged to form a pad-like elevation underneath opening to epiphallus. Epiphallus coiled, attached to penis by connective tissue; slightly shorter than penis, epiphallic flagellum short; inner epiphallic wall supporting complexly interdigitating, delicate longitudinal pilasters along entire length, some of which reaching into the flagellum; distal end of inner epiphallic wall with highly complex armature consisting of fine lamellae and net-like corrugations bound by longitudinal pilasters. Penial retractor muscle moderately long. Vas deferens entering epiphallus close to distal end, thin. Vagina much longer than free oviduct. Free oviduct coiling.

Comparative Remarks

Shell similar to *K. umbonis* and *K. somniator* overall, differing by slightly larger size, flatter shape, almost unconcealed umbilicus, and weakly developed periostracal microsculpture. Complex armature of inner penial and epiphallic walls is characteristic.

Distribution (Fig. 207)

Boongaree Island.

Kimberleytrachia alphacentauri n. sp.
Figs. 208C, 215–217

Type Locality

Western Australia, northwestern Kimberley, Bonaparte Archipelago, central section of

Boongaree Island, 15°04'36"S, 125°11'12"E; coll. Michael Shea, 8/08/2007, KIS 1–28 (rainforest on N-facing sandstone scree below escarpment; under rocks).

Material Examined

Holotype WAM S58465 (preserved specimen, Fig. 208C). Paratypes AM C471810

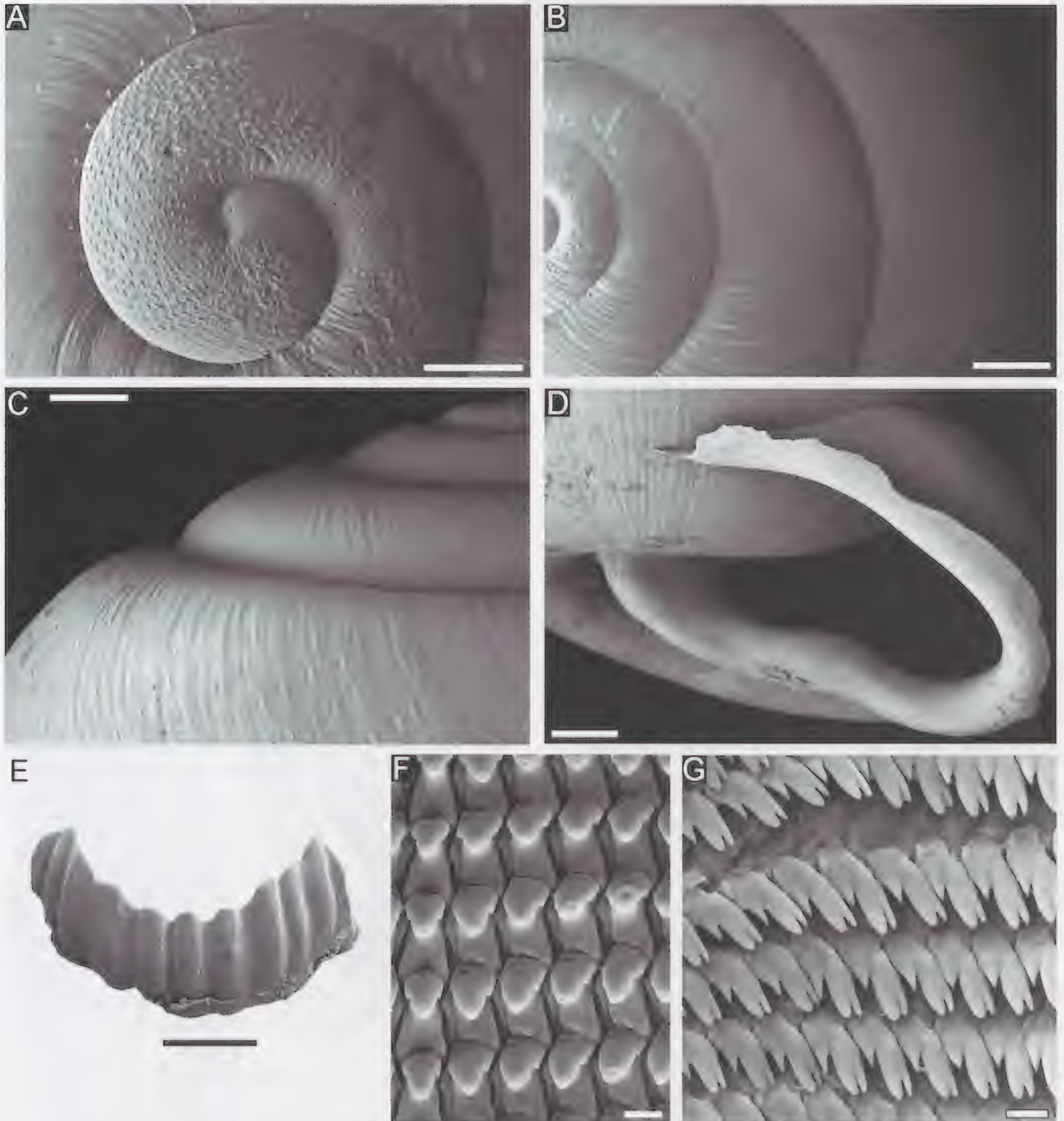


FIG. 215. SEM micrographs of *Kimberleytrachia alphacentauri* n. sp. (Boongaree Island). A–D: Shell paratype WAM S36403. A: Apical view showing protoconch. Scale bar = 500 μ m; B: Sculpture across first whorls of shell viewed from above; C: Lateral view of last whorls showing sculpture on last whorls; D: Close-up of aperture. Scale bars = 1 mm; E: Jaw paratype AM C471810. Scale bar = 200 μ m; F–G: Radula paratype AM C471810. Scale bars = 100 μ m; F: Central and inner lateral teeth viewed from above; G: Middle marginal teeth viewed from above.

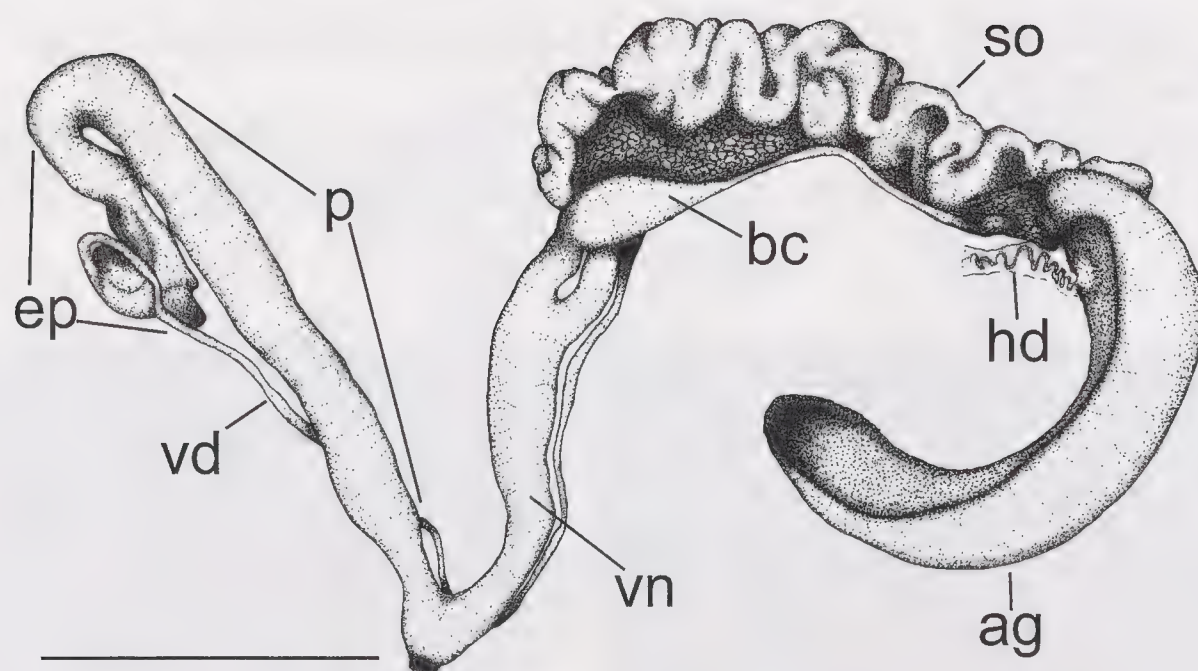


FIG. 216. Genital anatomy of *Kimberleytrachia alphacentauri* n. sp. paratype AM C471810 (Boongaree Island, August). Scale bar = 5 mm.

(5 preserved specimens), WAM S36740 (10 preserved specimens), AM C471811 (4 shells), WAM S36406 (6 shells) from type locality; WAM S36403 (shell) from 15°04'21"S, 125°11'06"E; WAM S36404 (shell) from 15°04'31"S, 125°11'07"E; WAM S36405 (shell) from 15°04'26"S, 125°10'46"E; WAM S36741 (9 preserved specimens), WAM S36407 (6 shells) from 15°04'15"S, 125°11'14"E; WAM S36408 (shell) from 15°04'16"S, 125°10'47"E; WAM S36402 (preserved specimen) from 15°04'00"S, 125°11'11"E; WAM S36742 (8 preserved specimens), WAM S36445 (6 shells) from 15°04'36"S, 125°11'18"E; AM C471812 (3 preserved specimens), WAM S37682 (6 preserved specimens) from 15°04'30"S, 125°11'21"E; WAM S37691 (2 preserved specimens) 15°04'19"S, 125°11'18"E.

Etymology

For the name of the brightest star in the constellation Centaurus, Alpha Centauri, a bright star that was important in naval navigation, noun in apposition.

Description

Shell (Figs. 208C, 215A–D): Small ($D=10.8$ – 14.3 mm; Table 11), delicate, discoidal to very broadly conical with low spire; periphery well rounded to slightly angulate, whorls separated by rather shallow suture; umbilicus narrowly open, ~ 1 mm wide, 30–90% concealed; yellowish brown. Last whorl very strongly descending behind aperture; angle of aperture 15–30°; elongate, simple, inside whitish, with moderately expanded, weakly

reflected, thin lip; palatal node absent, basal node well developed. Protoconch 1.7 mm in diameter, comprising one whorl, with very fine, sparse pustules. Teleoconch smooth, with well-developed radial growth lines; microsculpture comprises sparsely distributed, fine periostracal setae, worn in adult shells giving them a

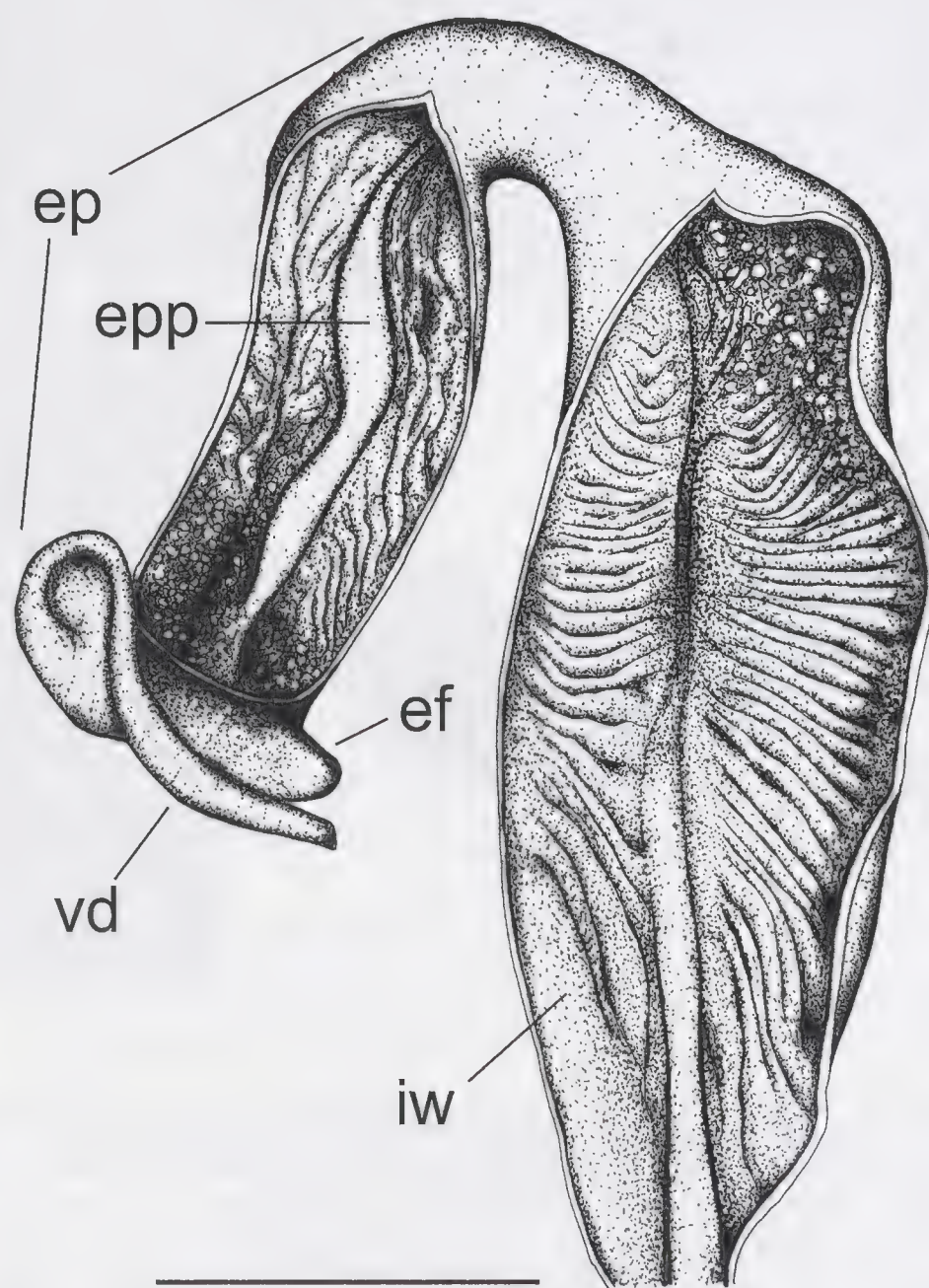


FIG. 217. Penial anatomy of *Kimberleytrachia alphacentauri* n. sp. paratype AM C471810 (Boongaree Island, August). Scale bar = 3 mm.



FIG. 218. Photograph of living holotype of *Kimberleytrachia aequum* n. sp.

glossy shine; inner umbilical whorls covered with some pustules.

Digestive anatomy (Fig. 215E–G): Jaw consisting of about 10 plates. Radula C + 12–14 + 3–4 + 20–22.

Genital anatomy (Figs. 216–217): Penis elongate, tubular, longer than vagina. Inner penial wall with regularly arranged, lateral lamellae which gradually become more oblique proximally; distal end of wall supporting some irregularly arranged, small pustules; a longitudinal gutter forms along entire length of inner penial wall separating lateral lamellae in the middle. Epiphallus bent, much shorter than penis; inner wall supports very fine, irregular pustulation near proximal end near opening to deferens, irregular longitudinal folds plus one strong longitudinal pilaster form along entire length; flagellum very short. Penial retractor muscle stubby. Vas deferens entering near distal end; thin. Vagina much longer than free oviduct.

Mitochondrial Differentiation

Intraspecific genetic distance (3 sequences): 0.001–0.006; interspecific genetic distances: 0.272–0.274 with respect to *K. crawfordi* from Storr Island (1 sequence), 0.081–0.113 to all other congeners (13 sequences, 6 species).

Comparative Remarks

Shell significantly smaller than other species treated here. *Kimberleytrachia deflecta* from

Prince Regent Reserve is similar with respect to shell shape, size and sculpture but differs most significantly in anatomy of inner penial wall (i.e., lack of regularly arranged, lateral lamellae). Armature of inner penial consisting mainly of lateral lamellae is characteristic (only similar in *K. somniator*).

Distribution (Fig. 207)

Boongaree Island.

***Kimberleytrachia aequum* n. sp.**
Figs. 218–220

Type Locality

Western Australia, northwestern Kimberley, Bonaparte Archipelago, Boongaree Island.

Material Examined

Holotype WAM S29303 (isolated soft body without shell; Fig. 218).

Etymology

From “*aequum*” (Latin = flat) for its flattened shell; noun in apposition.

Description

Shell (Fig. 218, living animal): Known only from a photograph, medium sized, with about

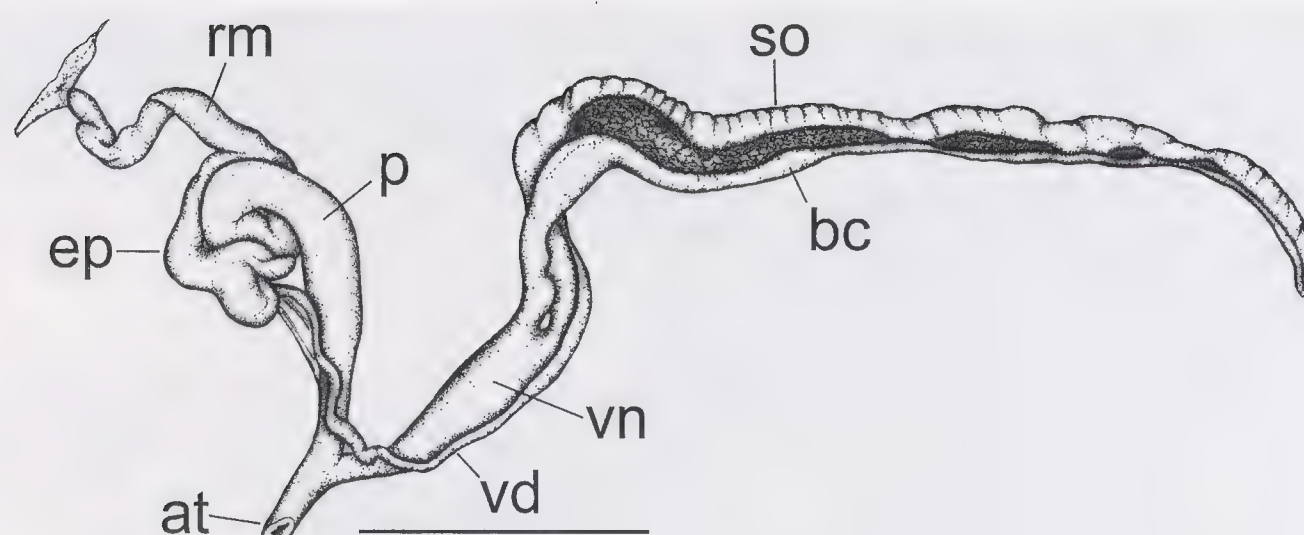


FIG. 219. Genital anatomy of *Kimberleytrachia aequum* n. sp. holotype WAM S29303 (Boongaree Island, February). Note that distal parts of spermoviduct, bursa copulatrix and albumen gland are lacking. Scale bar = 5 mm.

five whorls, almost perfectly dicoidal in shape with flat spire, thin and translucent, with well-rounded periphery; essentially smooth with well-developed microsculpture of dense periostracal setae that cover the entire shell; last whorl descending behind aperture; apertural lip well expanded.

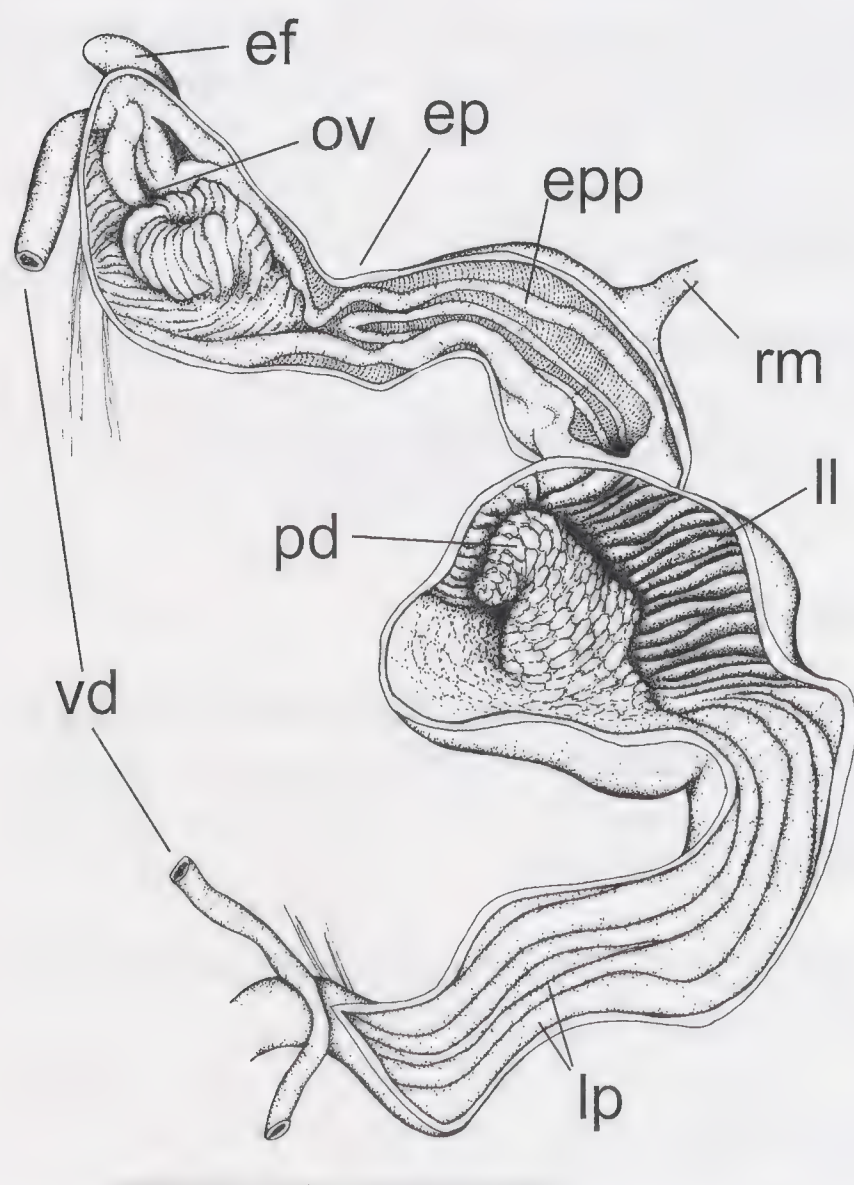


FIG. 220. Penial anatomy of *Kimberleytrachia aequum* n. sp. holotype WAM S29303 (Boongaree Island, February). Note that most distal part of spermoviduct, bursa copulatrix and albumen gland are lacking. Scale bar = 3 mm.

Genital anatomy (Figs. 219–220): Penis elongate, moderately long, about same length as vagina. Distal half of inner penial wall with well-developed lateral lamellae; proximal half supporting strong longitudinal pilasters; underneath opening to epiphallus densely packed and partly fused pustules form pad-like elevated structure. Epiphallus bent, slightly shorter than penis; inner wall with two strong and two thinner longitudinal pilasters; at distal end near opening to vas deferens and flagellum a collar is formed by elevated pilasters; flagellum short. Penial retractor muscle comparatively long. Vas deferens entering near distal end; thin. Vagina longer than free oviduct.

Mitochondrial Differentiation

Interspecific genetic distances (1 sequence): 0.226 with respect to *K. crawfordi* from Storr Island (1 sequence), 0.095–0.125 to all other congeners (13 sequences, 6 species).

Comparative Remarks

The holotype is the only known specimen. It was photographed alive but the shell was subsequently eaten by other snails; remaining body parts permitted dissection of most parts genitalia as well as DNA sequencing. From information available, it is clear that *K. aequum* is distinct from any other known species on Boongaree Island as well as the mainland. It is characterised by an almost perfectly dicoidal shell and by a peculiar anatomy of the inner penial wall, which supports a complex armature of strongly developed longitudinal pilasters that are corrugated at their distal end. In addition,

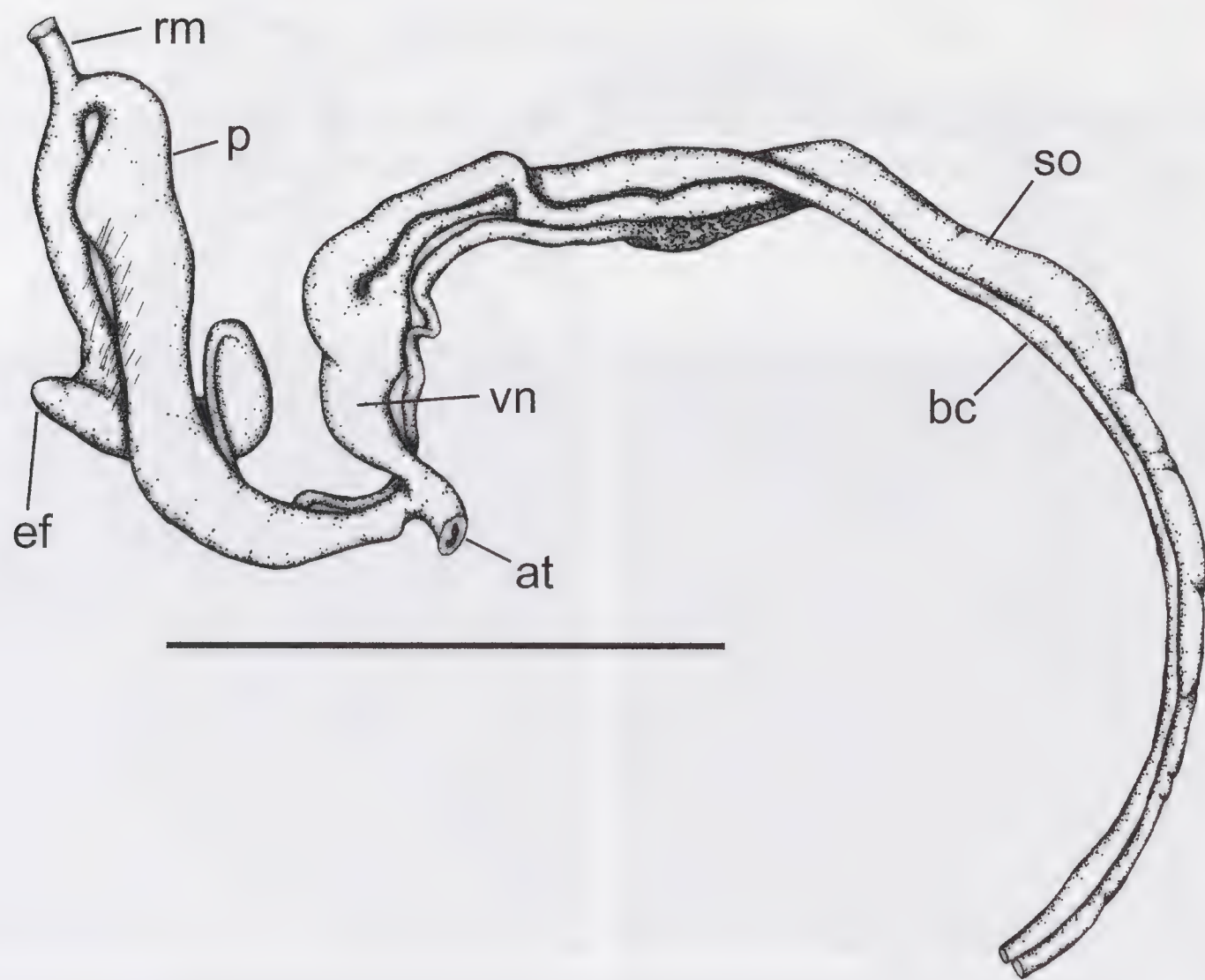


FIG. 221. Genital anatomy of *Kimberleytrachia hirsuta* n. sp. holotype WAM S37643 (1.3 km S of Halfway Bay, February). Note that distal parts of spermatheca, bursa copulatrix and albumen gland are lacking. Scale bar = 5 mm.

complex armature of inner penial and epiphallic walls is characteristic. *Kimberleytrachia canopi* has a similarly complex penial wall armature, which comprises corrugated lamellae, but a more complex armature of the epiphallic wall.

Distribution (Fig. 207)

Boongaree Island.

Kimberleytrachia hirsuta n. sp.
Figs. 221, 222

Type Locality

Western Australia, central Kimberley coast, Hanover Bay, Munster Water, mainland 1.3 km S of Halfway Bay of, 15°20'15"S, 124°49'23"E; coll. Vince Kessner, 11/02/2009, KIS 3-133 (S-facing vine thicket at the base of sandstone cliffs; in crevices).

Material Examined

Holotype WAM S37643 (preserved specimen).

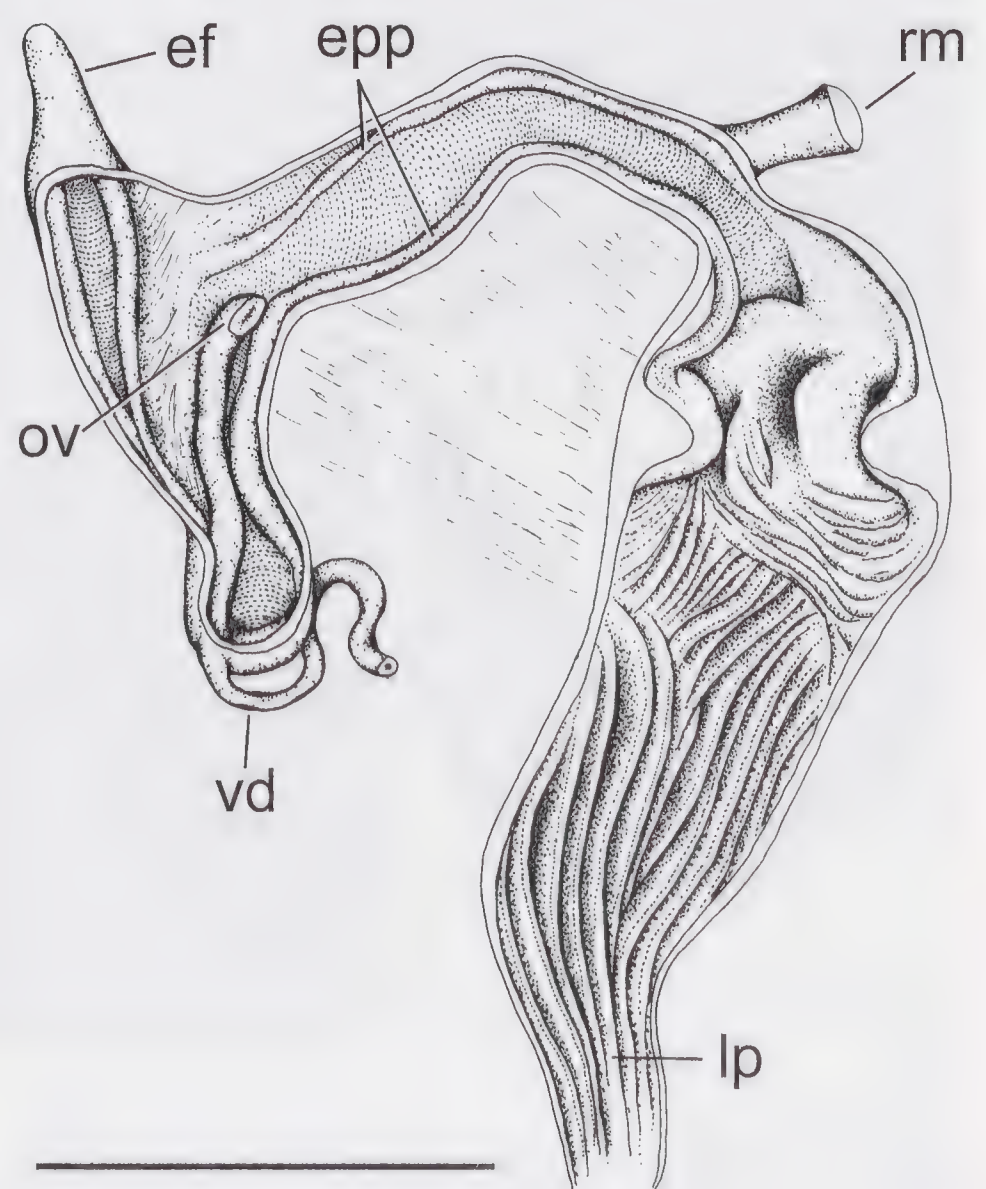


FIG. 222. Penial anatomy of *Kimberleytrachia hirsuta* n. sp. holotype WAM S37643 (1.3 km S of Halfway Bay, February). Scale bar = 2 mm.

Etymology

From "*hirsute*" (Latin = hairy), for the well-developed sculpture of periostracal setae on the shell of the holotype; adjective of feminine gender.

Description

Shell: Moderate to large in size ($D = 18.6$ mm, mature specimen), delicate to thin, very broadly conical with low spire; periphery well

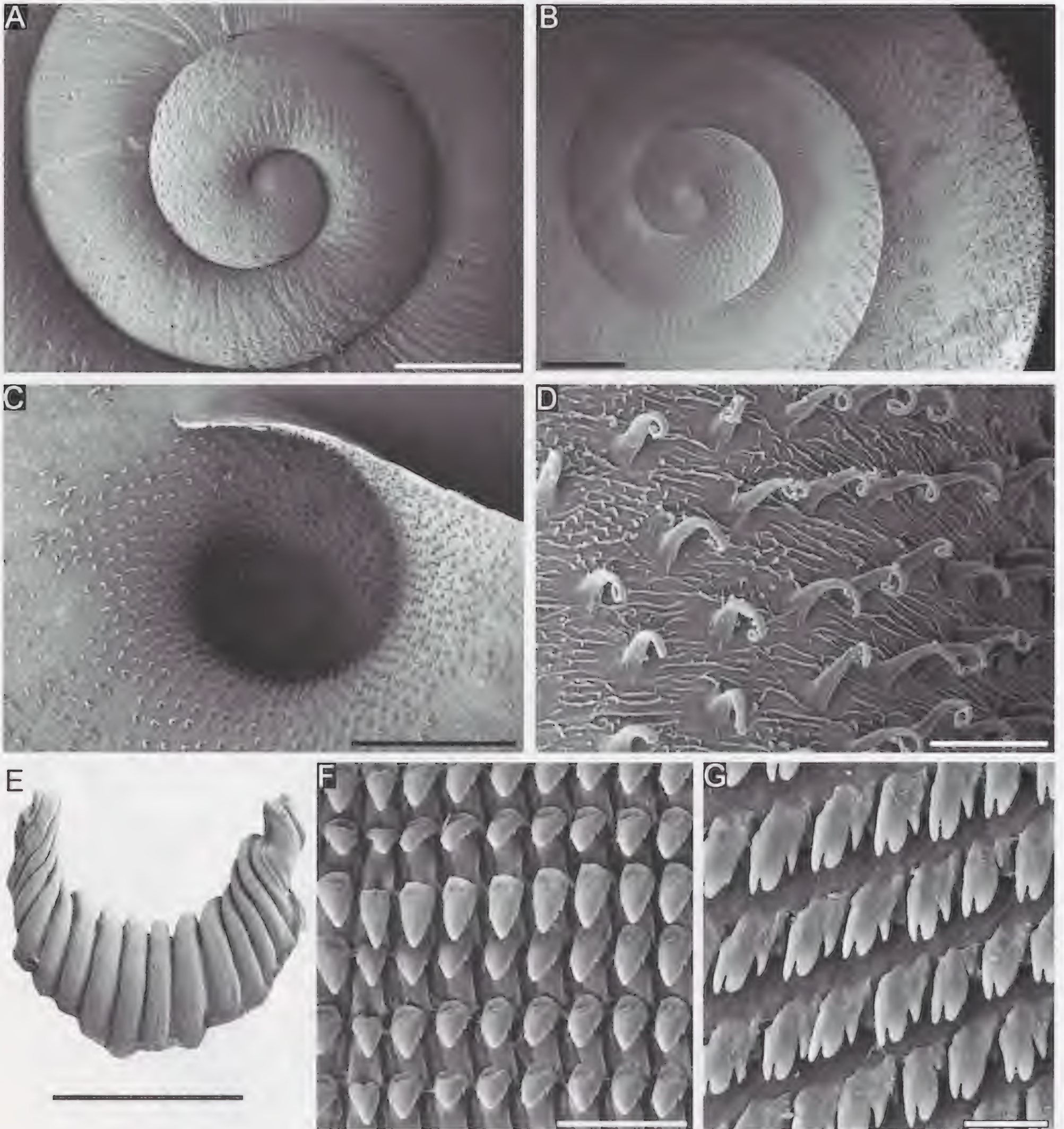


FIG. 223. SEM micrographs of *Kimberleytrachia chartacea* n. sp. (Uwins Island). A–D: Shell. A: Apical view showing protoconch, paratype WAM S37353; B: Sculpture across first whorls of shell viewed from above; C: Umbilicus; D: Close-up of micro-sculpture on last whorl. B–D: paratype WAM S37355 (juvenile shell). Scale bars A–C = 1 mm, D = 100 µm; E: Jaw paratype AM C471813. Scale bar = 500 µm; F–G: Radula paratype AM C471813. F: Central and inner lateral teeth viewed from above. Scale bar = 50 µm; G: Middle marginal teeth viewed from above. Scale bar = 20 µm.

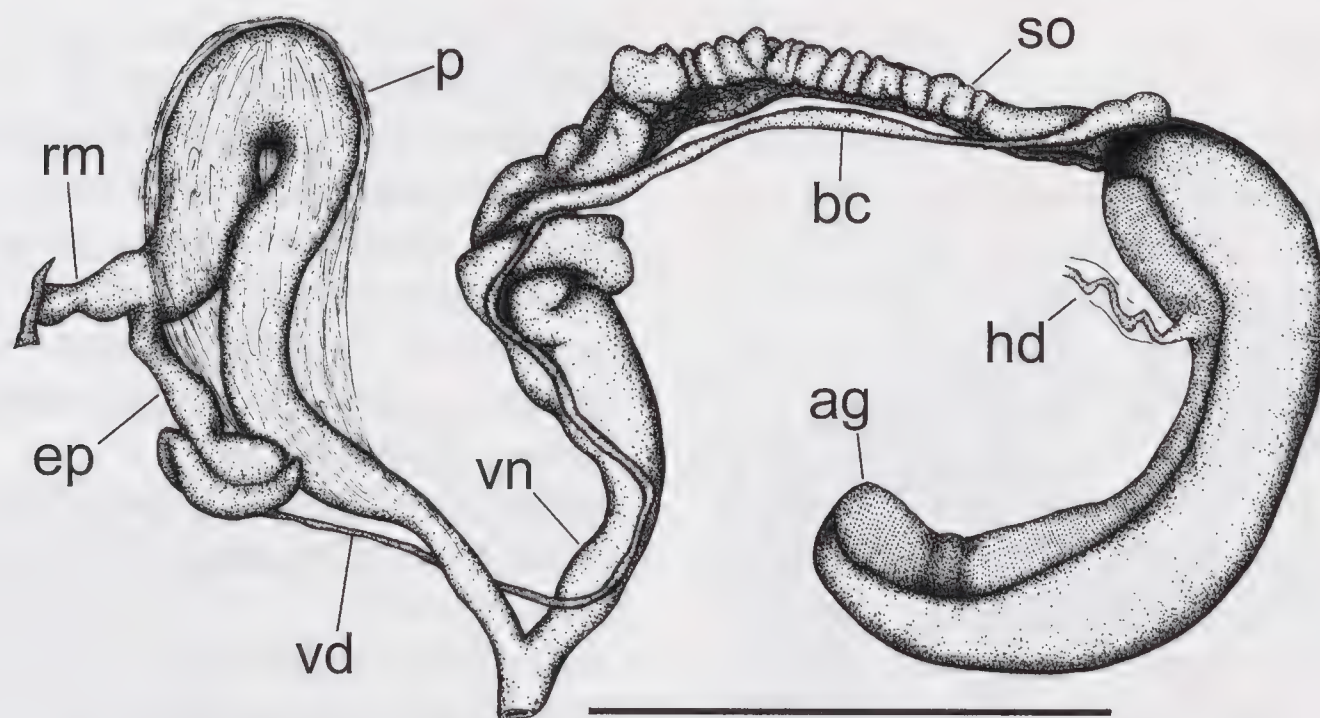


FIG. 224. Genital anatomy of *Kimberleytrachia chartacea* n. sp. paratype AM C471813 (Uwins Island, June). Scale bar = 10 mm.

rounded, whorls separated by rather shallow suture; umbilicus ~ 3 mm wide, not concealed; yellowish brown. Aperture elongate, simple. Teleoconch smooth, with faint radial growth lines, densely covered with fine periostracal setae, regularly arranged in radial pattern; inner umbilical whorls with well-developed pustules that support long setae.

Genital anatomy (Figs. 221–222): Penis elongate, longer than vagina. Distal end of inner penial wall supporting dense lateral lamellae; proximal two thirds supporting narrow, well-developed longitudinal pilasters; pad-like thickening forms underneath opening to epiphallus. Epiphallus bent, shorter than penis; inner wall essentially smooth, one longitudinal pilaster forming along entire length, two additional pilasters form at distal end, reaching into short flagellum. Penial retractor muscle short. Vas deferens entering near distal end, extending into lumen of epiphallus; thin. Vagina about same length as free oviduct.

Comparative Remarks

The holotype is a subadult specimen with unfinished apertural lip and was not photographed. Shell differs from other congeners by very pronounced development of periostracal setae being visible with naked eye. Distinctive features of genital anatomy are well-developed, narrowly arranged lateral lamellae of inner penial wall and essentially smooth epiphallic wall.

Distribution (Fig. 207)

Mainland near Halfway Bay, west of Prince Regent Reserve.

Kimberleytrachia chartacea n. sp. Figs. 208D, 223–225

Type Locality

Western Australia, central Kimberley coast, Bonaparte Archipelago, Hanover Bay, Uwins Island, 15°15'32"S, 124°48'08"E; coll. Vince Kessner, 9/06/2008, KIS 3–106 (vine thicket and large fig trees on upper slopes, piles of sandstone rocks; in crevices, under overhangs).

Material Examined

Holotype WAM S58466 (preserved specimen, Fig. 208D). Paratypes AM C471813 (8 preserved specimens), WAM S37071 (18 preserved specimens), WAM S37358 (3 shells) from type locality; WAM S37064 (10 preserved specimens), WAM S37351 (shell) from 15°15'09"S, 124°48'10"E; AM C471814 (8 preserved specimens), WAM S37065 (10 preserved specimens) from 15°15'44"S, 124°48'08"E; AM C471815 (5 preserved specimens), WAM S37066 (11 preserved specimens), WAM S37352 (4 shells) from 15°15'52"S, 124°47'05"E; WAM S37067 (9 preserved specimens), WAM S37353 (2 shells) from 15°16'02"S, 124°48'09"E; WAM S37068 (8 preserved specimens), WAM S37354 (shell) from 15°15'25"S, 124°48'04"E; WAM S37069 (6 preserved specimens), WAM S37355 (3 shells) from 15°15'26"S, 124°48'08"E; WAM S37070 (7 preserved specimens), WAM S37356 (2 shells) from 15°15'36"S, 124°47'52"E; WAM S37357 (shell) from 15°15'45"S, 124°47'54"E.

Additional, non-type material. WAM S37642 (5 preserved specimens) from southern part

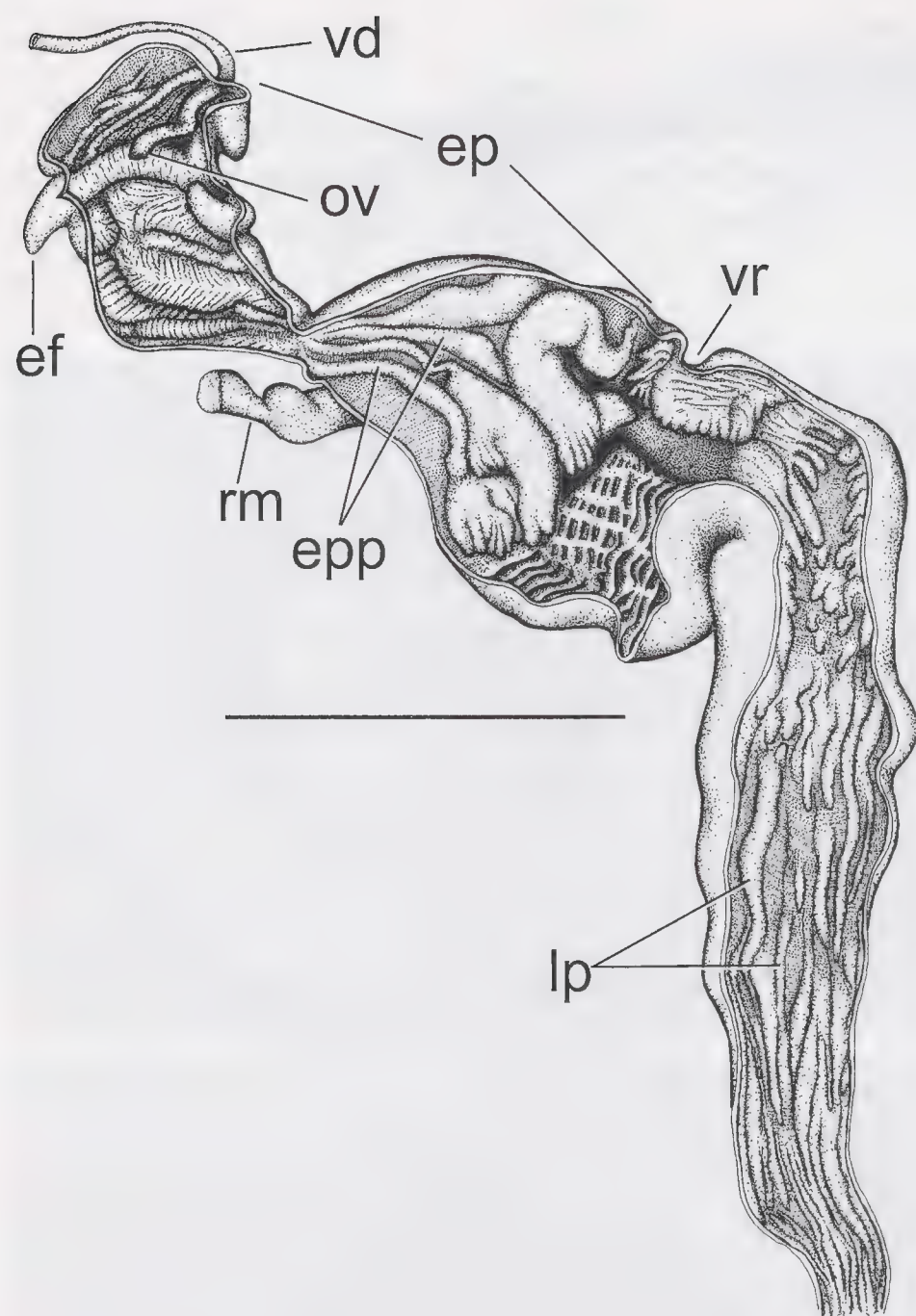


FIG. 225. Penial anatomy of *Kimberleytrachia chartacea* n. sp. paratype AM C471813 (Uwins Island, June). Scale bar = 5 mm.

of Uwins Island, 15°17'40.2"S, 124°47'58.4"E; WAM 37696 (preserved specimen), WAM S49039 (3 shells) from Mictyis Island, 2.5 km NW of Uwins Island, 15°13'12"S, 124°47'23"E.

Etymology

From "*chartaceus*" (Latin, masc = made from paper), for the delicate, transparent shell; adjective of feminine gender.

Description

Shell (Figs. 208D, 223A–D): Moderate to large in size ($D = 18.8\text{--}22\text{ mm}$; Table 11), very delicate, almost discoidal to very broadly conical with low spire; periphery well rounded to slightly angulated, whorls separated by well-incised suture; umbilicus ~ 3 mm wide, 10–30% concealed; colour yellowish brown to amber, with lighter base. Protoconch ~ 2.75 mm in diameter, comprising 1.5–2 whorls, with coarse pustules. Teleoconch essentially smooth; microsculpture of curled periostracal

setae and fine ridglets, mostly worn in adult shells giving them a glossy shine; inner umbilical whorls with well-developed pustules that support setae. Last whorl strongly descending behind aperture. Angle of aperture 15–30°; wide, simple, inside with whitish suffusion, moderately to strongly expanded, weakly reflected, sharp lip; palatal node absent, basal node well developed.

Digestive anatomy (Fig. 223E–G): Jaw with more than 20 plates. Radula C + 17–19 + 3–4 + 22–23.

Genital anatomy (Figs. 224–225): Penis elongate, longer than vagina. Inner penial wall supporting densely arranged pilasters, partly fused, which gradually change orientation from lateral at distal to longitudinal at proximal end of inner penial wall; longitudinal gutter forms in centre of entire length of wall; pad-like thickening forms proximal of vergic ring. Epiphallus bent, shorter than penis; inner wall with complex armature consisting of longitudinal pilasters at proximal end and lateral lamellae at distal end; flagellum short. Penial retractor muscle short. Vas deferens entering near distal end; thin. Vagina about same length as free oviduct. Bursa copulatrix with inflated head.

Mitochondrial Differentiation

Intraspecific genetic distance (5 sequences): 0.0–0.010; interspecific genetic distances: 0.270–0.273 with respect to *K. crawfordi* from Storr Island (1 sequence), 0.081–0.101 to all other congeners (10 sequences, 6 species).

Comparative Remarks

Similar to *K. deflecta* with respect to shell shape and lip development, but much larger in size. Shell flatter than that of *K. somniator*, as indicated by a lower H/D ratio. Complex anatomy of inner penial wall highly characteristic.

Distribution (Fig. 207)

Uwins and Mictyis islands, Hanover Bay.

***Kimberleytrachia amplirhagadoides* n. sp.**
Figs. 208E, 226–228

Type Locality

Western Australia, central Kimberley coast, Bonaparte Archipelago, Camden Sound,

NW section of Augustus Island, 15°20'11"S, 124°31'10"E; coll. Vince Kessner, 13/02/2009, KIS 1–67 (vine thicket in valley on moderately steep W-facing slopes at base of sandstone cliffs; active on ground and boulders at night after rain).

Material Examined

Holotype WAM S58467 (preserved specimen, Fig. 208E). Paratypes WAM S37639 (2 preserved specimens), AM C471816 (3 shells), WAM 49018 (4 shells) from type locality; WAM S37075 (preserved specimen) from 15°19'58"S, 124°31'01"E; WAM S37346 (2 shells) from 15°21'05"S, 124°31'47"E; WAM S37347 (3 shells) from 15°20'59"S, 124°31'30"E; WAM S37348 (3 shells) from 15°21'24"S, 124°31'39"E; WAM S37072 (2 preserved specimens), WAM S37349 (2 shells) from 15°20'16"S, 124°31'16"E.

Etymology

Derived from the genus name *Amplirhagada* and the Greek suffix “-oides” (οειδης, an adjective suffix for nouns = like, resemble), for shell resembling that of some *Amplirhagada* species; noun in apposition.

Description

Shell (Figs. 208E, 226): Moderate to large in size ($D = 20\text{--}22\text{ mm}$; Table 11), delicate to thin, broadly conical with moderately elevated spire; periphery well rounded to slightly angulated, upper sector of whorls may be slightly shouldered, whorls separated by well-incised suture; umbilicus $\sim 2\text{ mm}$ wide, 60–90% concealed; colour yellowish brown to amber, with lighter base. Protoconch $\sim 2.5\text{ mm}$ in diameter, comprising one whorl, with coarse pustules. Teleoconch with faint radial growth lines, microsculpture of curled

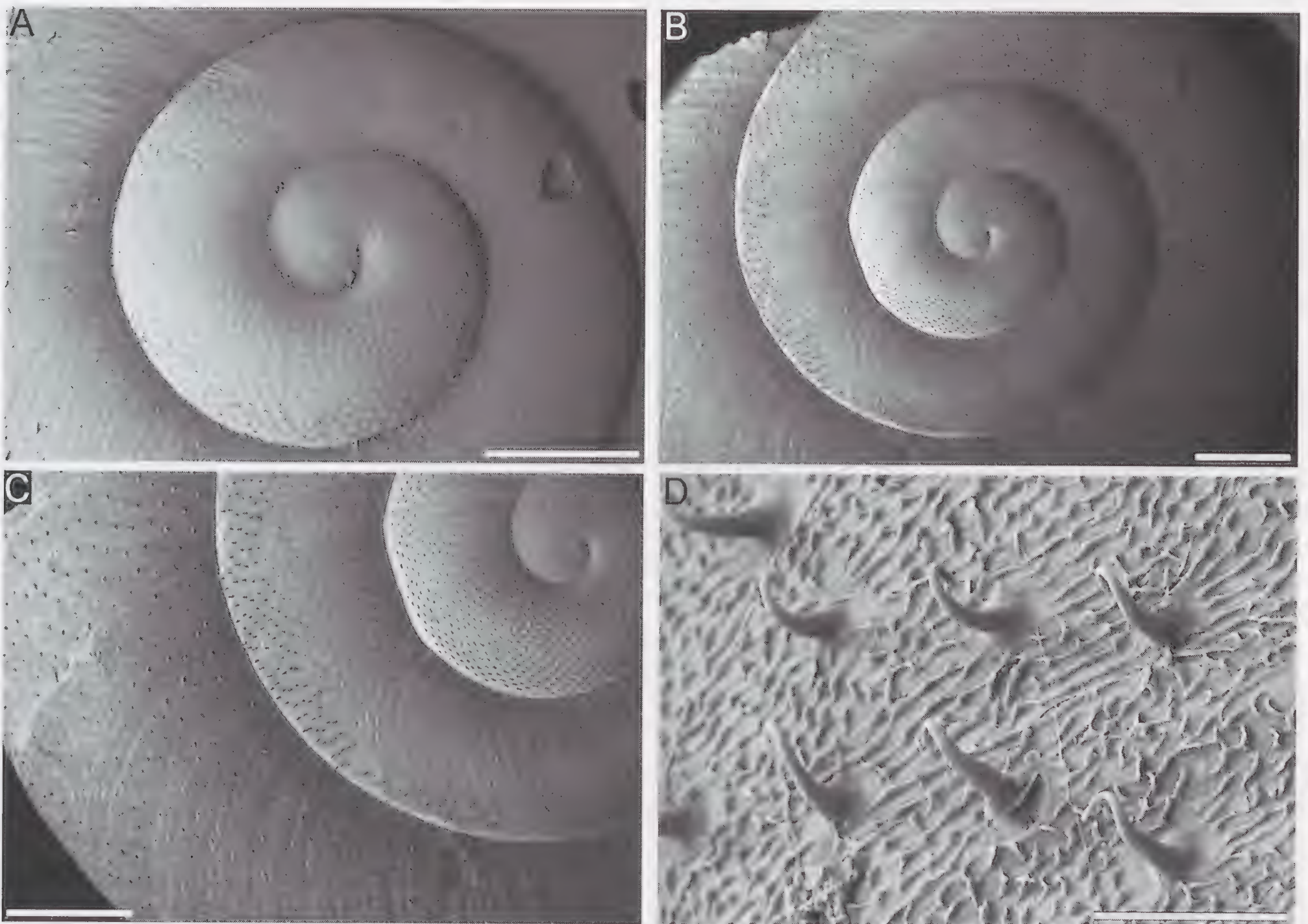


FIG. 226. SEM micrographs of the shell of *Kimberleytrachia amplirhagadoides* n. sp. (NW Augustus Island). A: Apical view showing protoconch and first whorl, paratype WAM S37348; B–C: Sculpture across first whorls viewed from above, paratype WAM S37346 (sub-adult shell). Scale bars = 1 mm; D: Close-up of micro-sculpture on last whorl, paratype WAM S37349. Scale bar = 100 µm.

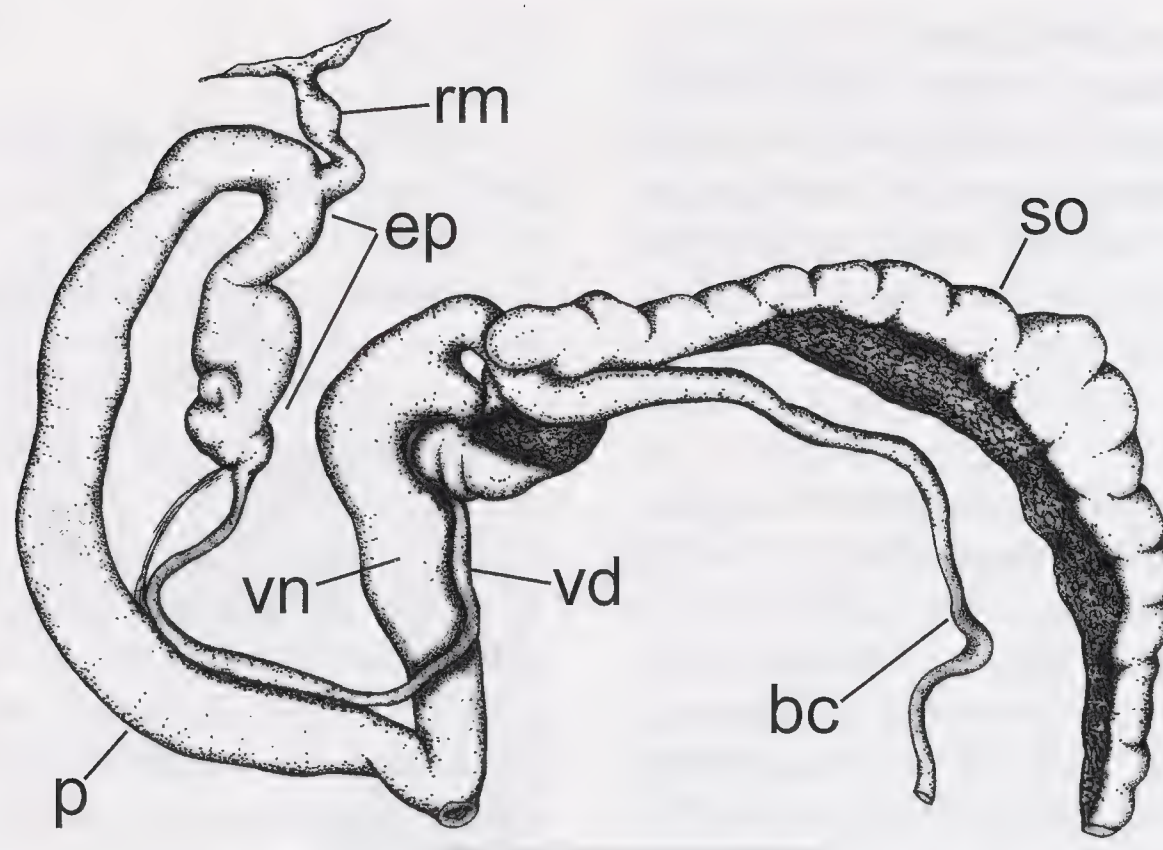


FIG. 227. Genital anatomy of *Kimberleytrachia amplirhagadoides* n. sp. paratype WAM S37639 (NW Augustus Island, February). Note that distal parts of bursa copulatrix and spermatheca and albumen gland are lacking. Scale bar = 10 mm.

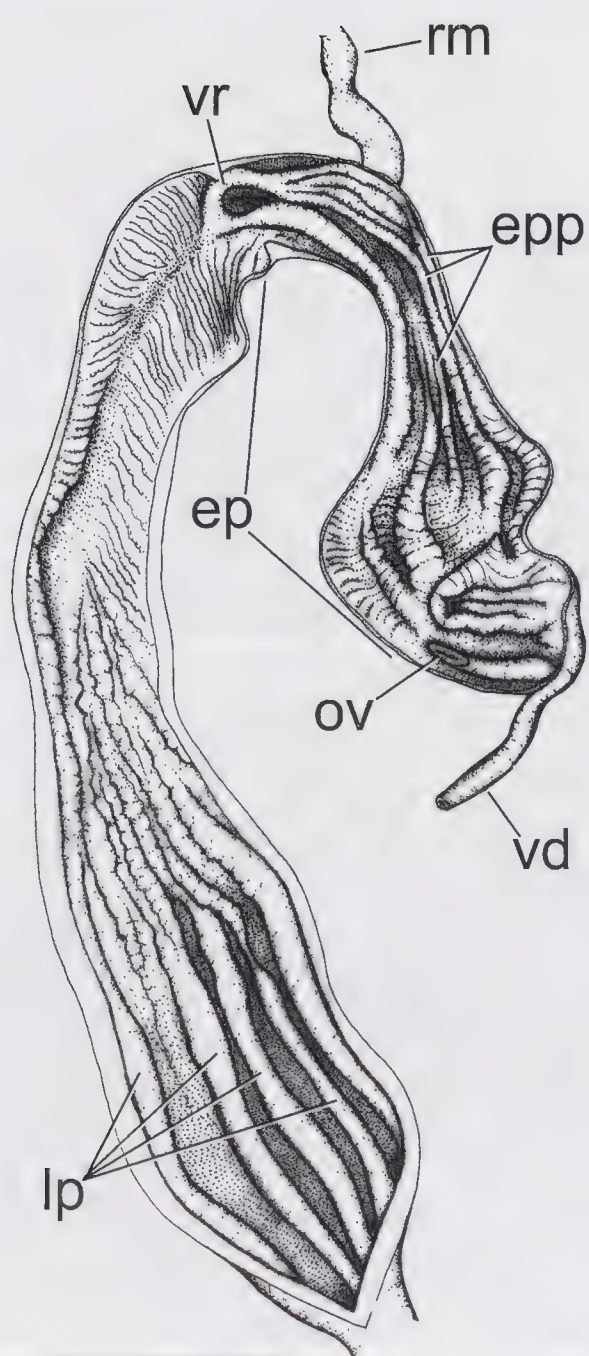


FIG. 228. Penial anatomy of *Kimberleytrachia amplirhagadoides* n. sp. paratype WAM S37639 (NW Augustus Island, February). Scale bar = 5 mm.

periostracal setae and fine ridglets, mostly worn in adult shells giving them a glossy shine; inner umbilical whorls with well-developed pustules that support setae. Last whorl weakly to moderately descending behind aperture. Angle of aperture 30–45°; wide, simple, inside with whitish suffusion, moderately to strongly expanded, weakly reflected, sharp lip; palatal node absent, basal node weakly to well developed.

Genital anatomy (Figs. 227–228): Penis elongate, longer than vagina. Distal end of inner penial wall supporting dense lateral lamellae, which are gradually transforming into well-developed, partly corrugated longitudinal pilasters at the proximal end. Epiphallus bent, shorter than penis; inner wall supporting several longitudinal pilasters along entire length. Penial retractor muscle short. Vas deferens entering near distal end, extending into lumen of epiphallus; thin. Vagina about same length as free oviduct.

Mitochondrial Differentiation

Intraspecific genetic distance (2 sequences): 0.003; interspecific genetic distances: 0.278–0.280 with respect to *K. crawfordi* from Storr Island (1 sequence), 0.091–0.125 to all other congeners (13 sequences, 6 species).

Comparative Remarks

Typical are compared to other congeneric species high spire and almost subglobose

shape, almost entirely concealed umbilicus, weakly descending aperture of shell, which resembles some shells of *Amplirhagada*. However, colouration and microsculpture are typical for *Kimberleytrachia*. The species differs from *K. somniator* by narrower umbilicus, from *K. alphacentauri* by much larger size, and from *K. chartacea* by higher elevation of shell and wider cross-section of whorls. Anatomy of inner penial wall consisting of lateral lamellae (distal) and longitudinal ribs (proximal) plus presence of strong longitudinal pilasters on epiphallic wall are characteristic features.

Distribution (Fig. 207)

Northwestern section of Augustus Island.

***Kimberleytrachia achernaria* n. sp.**
Figs. 208F, 229–231

Type Locality

Western Australia, central Kimberley coast, Brecknock Harbour, gully in the SE corner of Augustus Island, 15°23'45"S, 124°37'47"E;

coll. Vince Kessner, 12/02/2009, KIS 2–71 (vine thicket patch along creek line, steep rocky slopes, sandstone; active at night on ground after rain).

Material Examined

Holotype WAM S58468 (preserved specimen, Fig. 208F). Paratypes AM C471817 (3 preserved specimens), WAM S37640 (6 preserved specimens), AM C471818 (2 shells), WAM S49024 (5 shells) from type locality.

Etymology

For the name of the brightest star in the southern constellation Eridanus, Archenar; adjective of feminine gender.

Description

Shell (Figs. 208F, 229): Moderate to large in size ($D = 20\text{--}22$ mm; Table 11), delicate to thin, broadly conical with moderately to conspicuously elevated spire; periphery well rounded, whorls separated by rather shallow suture;

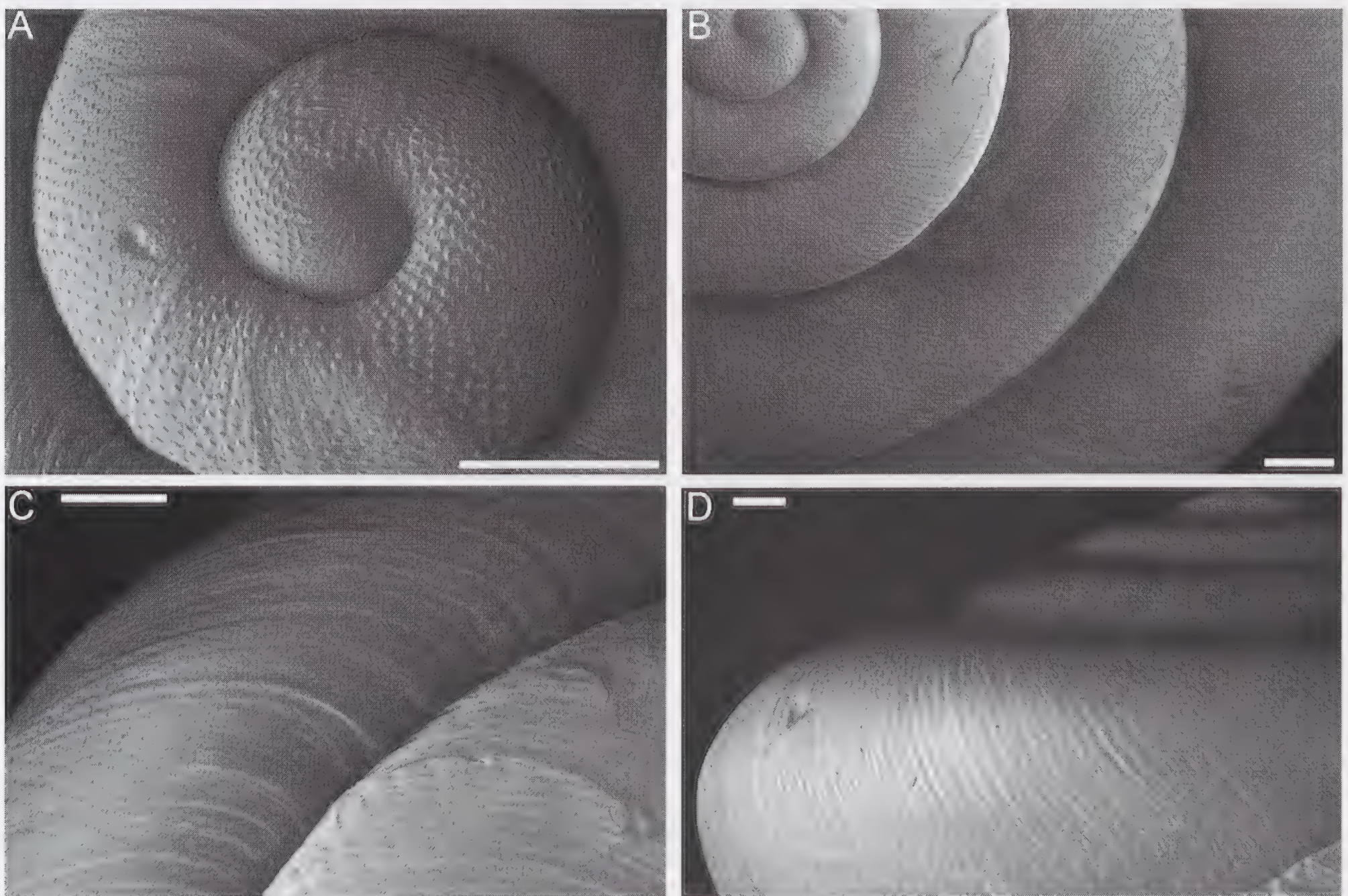


FIG. 229. SEM micrographs of the shell of *Kimberleytrachia achernaria* n. sp. paratype AM C471818 (SE Augustus Island). A: Apical view showing protoconch; B–C: Sculpture across first whorls viewed from above; D: Lateral view of shell. Scale bars = 1 mm.

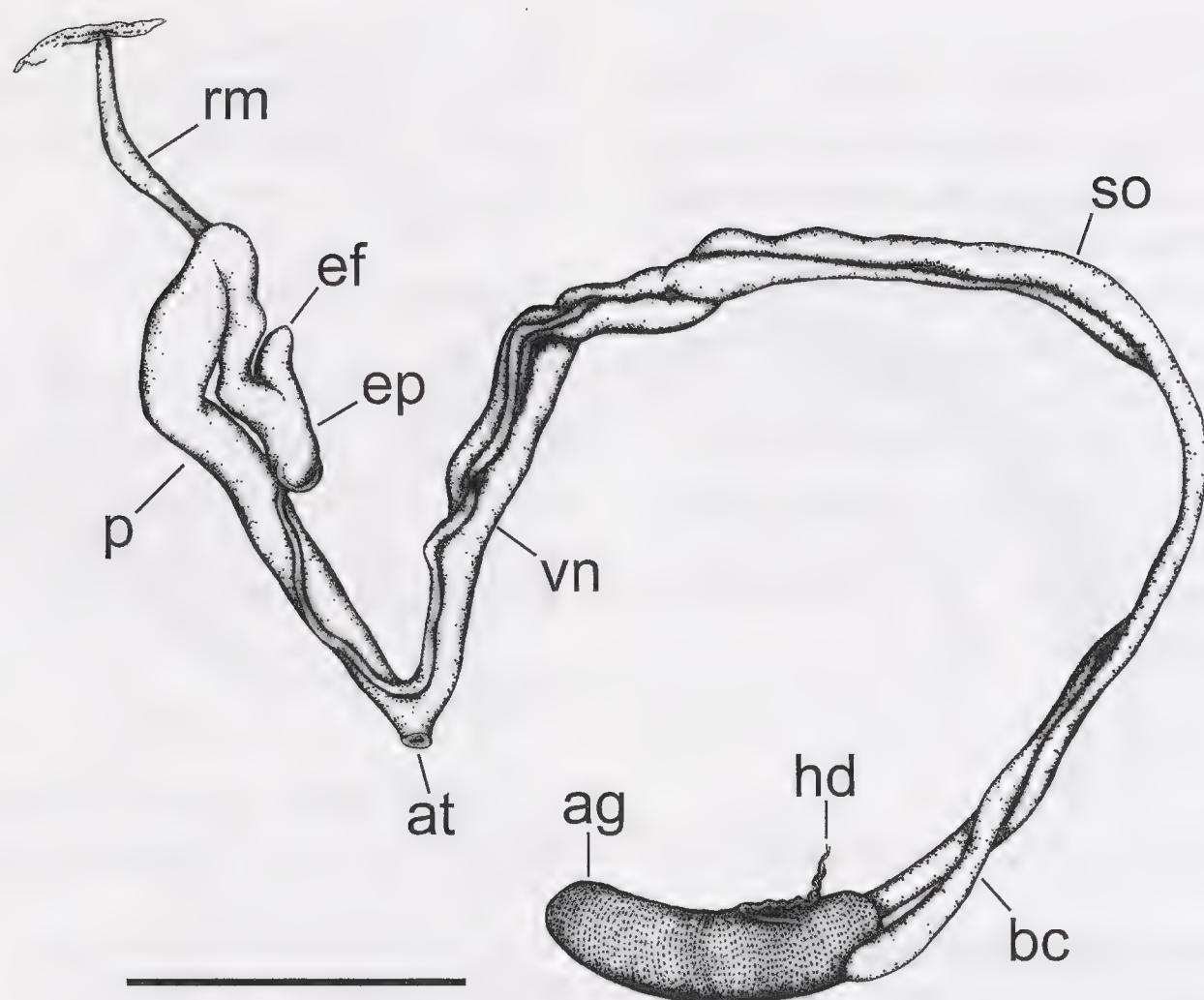


FIG. 230. Genital anatomy of *Kimberleytrachia achernaria* n. sp. holotype WAM S58468 (SE Augustus Island, February). Scale bar = 5 mm.

umbilicus ~ 2.5 mm wide, 10–30% concealed; colour yellowish brown, with whitish base. Protoconch ~ 2.5 mm in diameter comprising about one whorl, with coarse pustules. Teleoconch with faint radial growth lines, weakly developed microsculpture of very sparsely distributed periostracal setae, mostly worn in adult shells giving them a glossy shine; inner umbilical whorls with sparse pustules. Last whorl strongly descending behind aperture; angle of aperture ~ 30°; wide, simple, with moderately to strongly expanded, weakly reflected, sharp lip; palatal node absent, basal node weak to well developed.

Genital anatomy (Figs. 230–231): Penis elongate, longer than vagina. Distal end of inner penial wall supporting irregularly arranged lateral lamellae, proximal two thirds support narrow longitudinal pilasters, underneath opening to epiphallus a pad-like structure is formed, connected to longitudinal pilaster extending from epiphallus. Epiphallus bent, shorter than penis; inner wall supporting dense oblique lamellae plus one longitudinal pilasters along entire length, which extends into penial chamber connecting to pad; flagellum moderately long. Penial retractor muscle moderately long. Vas deferens entering near distal end, shortly extending into lumen of epiphallus; thin. Vagina about same length as free oviduct.

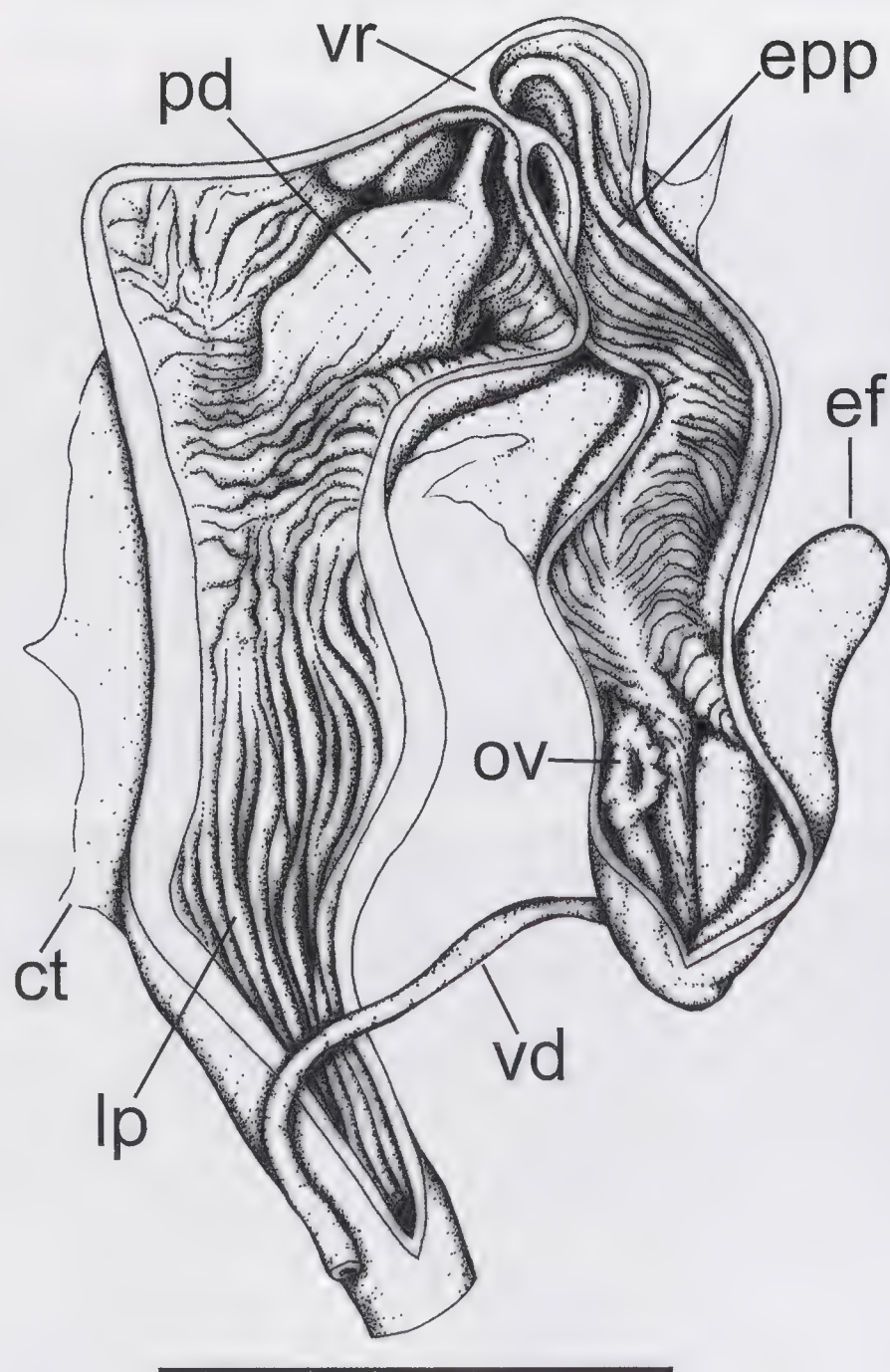


FIG. 231. Penial anatomy of *Kimberleytrachia achernaria* n. sp. holotype WAM S58468 (SE Augustus Island, February). Scale bar = 3 mm.

Mitochondrial Differentiation

Interspecific genetic distances (1 sequence): 0.283 with respect to *K. crawfordi* from Storr Island (1 sequence), 0.082–0.103 to all other congeners (14 sequences, 6 species).

Comparative Remarks

Shell most similar to *K. amplirhagadoides*, but comparatively flatter (wider diameter at same height); umbilicus not concealed, body whorl more strongly descending. Presence of large pad anterior to vergic ring being connected to a longitudinal pilaster extending from the epiphallus into penial lumen plus lateral lamellae at the epiphallic wall are typical features of this species.

Distribution (Fig. 207)

Southeastern section of Augustus Island.

Kimberleytrachia crucis n. sp.

Figs. 208G, 232–234

Type Locality

Western Australia, central Kimberley coast, Bonaparte Archipelago, Camden Sound, central section of D'Arcy Island, 15°17'25.3"S, 124°24'02.8"E; coll. Vince Kessner, 03/02/2009, KIS 1–62 (valley of seasonal stream, rock piles; active on ground at night after rain).

Material Examined

Holotype WAM S58469 (preserved specimen, Fig. 208G). Paratypes AM C471819 (preserved specimen), WAM S37641 (3 preserved specimens), AM C471820 (2 shells), WAM S37350 (4 shells), WAM S37073 (2 preserved specimens) from type locality.

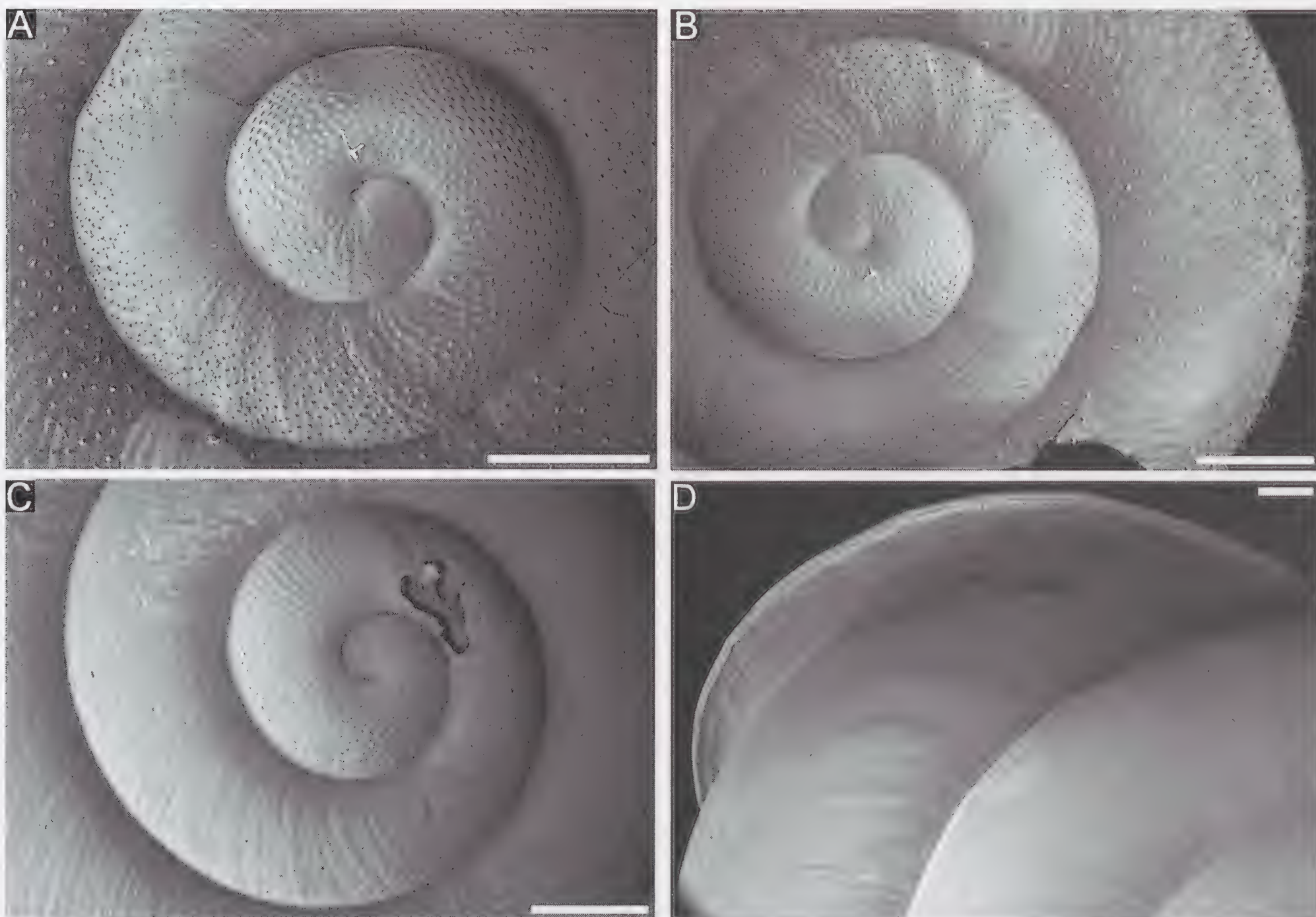


FIG. 232. SEM micrographs of the shell of *Kimberleytrachia crucis* n. sp. paratype AM C471820 (D'Arcy Island). A–B: Juvenile shell. A: Apical view showing protoconch; B: Sculpture across first whorls viewed from above; C–D: Adult shell. C: Apical view showing protoconch and first whorls; D: Close-up of last whorl near aperture viewed from above. Scale bars = 1 mm.

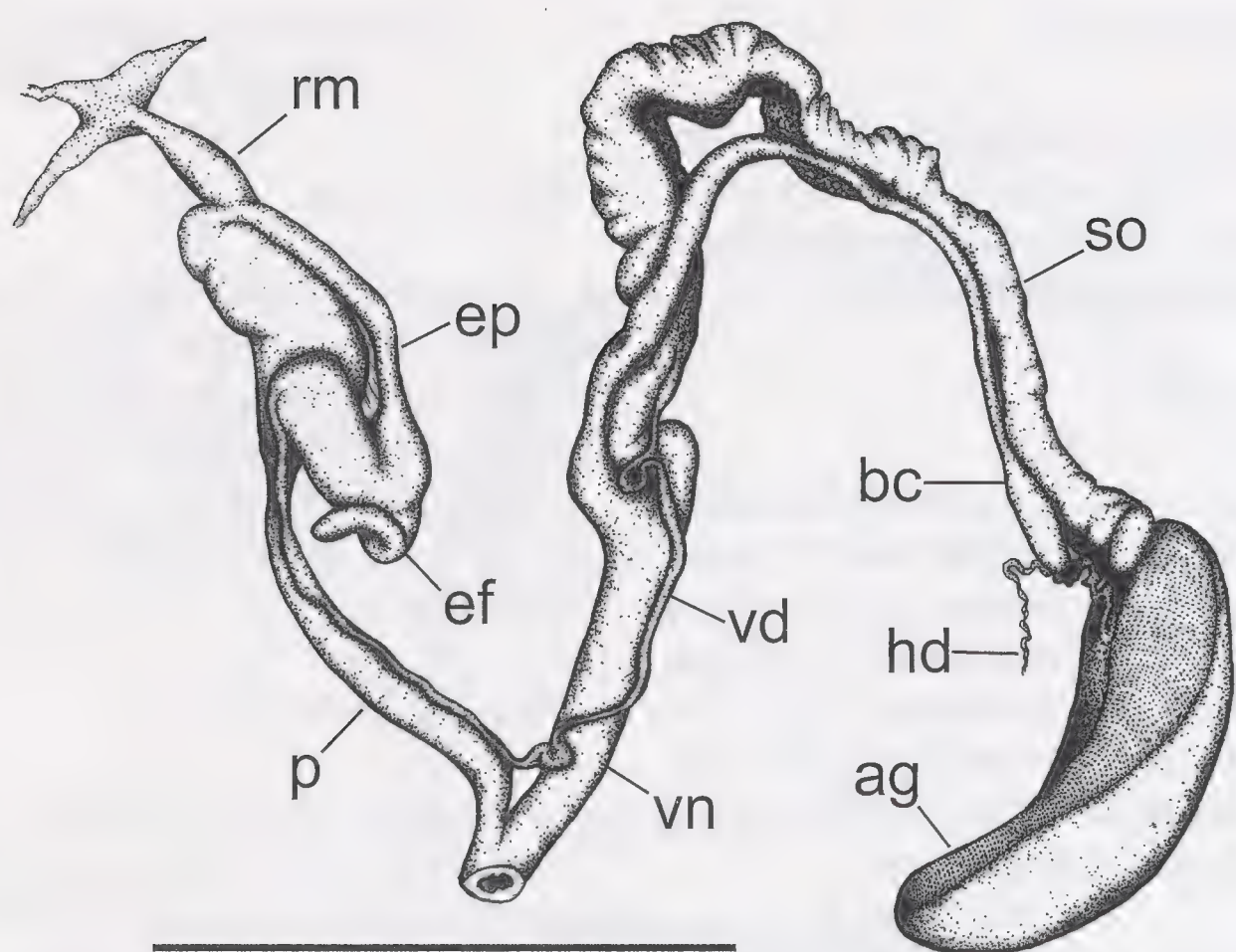


FIG. 233. Genital anatomy of *Kimberleytrachia crucis* n. sp. paratype WAM S37073 (D'Arcy Island, May). Scale bar = 10 mm.

Etymology

For the name of the constellation Southern Cross (Crux) of the southern sky; noun in genitive case.

Description

Shell (Figs. 208G, 232): Moderate to large in size (Table 11), delicate to thin, broadly conical with elevated spire; periphery well rounded, whorls separated by rather shallow suture; umbilicus ~ 2 mm wide, 30–70% concealed; colour yellowish brown, with whitish base; no banding. Protoconch ~ 2.5 mm in diameter, comprising about one whorl, with coarse pustules. Teleoconch with faint radial growth lines, microsculpture of periostracal setae, mostly worn in adult shells giving them a glossy shine; inner umbilical whorls with well-developed pustules that support setae. Last whorl weakly to moderately descending behind aperture; angle of aperture ~ 45°; wide, simple, with moderately to strongly expanded, weakly reflected, sharp lip; palatal node absent, basal node weak to well developed.

Genital anatomy (Figs. 233–234): Penis elongate, thin, about as long as vagina. Distal end of inner penial wall supporting dense lateral lamellae, proximal two thirds support narrow longitudinal pilasters, anterior to vergic ring a weak pad-like structure forms. Epiphallus bent,

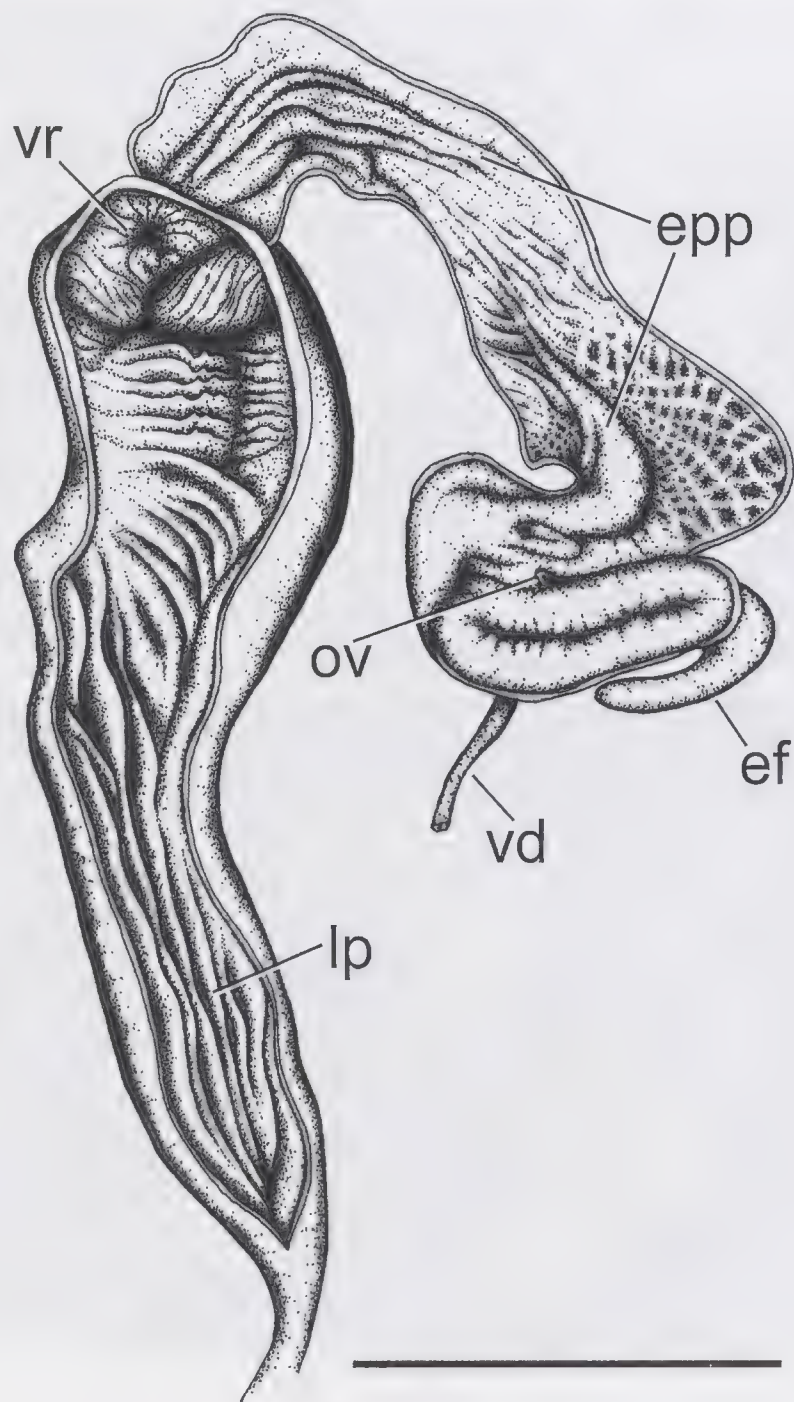


FIG. 234. Penial anatomy of *Kimberleytrachia crucis* n. sp. paratype WAM S37073 (D'Arcy Island, May). Scale bar = 3 mm.

shorter than penis; proximal end of inner wall supporting longitudinal pilasters, distal end supporting irregular net-like corrugations; flagellum short. Penial retractor muscle moderately long. Vas deferens entering near distal end, shortly extending into lumen of epiphallus; thin. Vagina longer than free oviduct.

Mitochondrial Differentiation

Interspecific genetic distances (1 sequence): 0.281 with respect to *K. crawfordi* from Storr Island (1 sequence), 0.092–0.120 to all other congeners (14 sequences, 6 species).

Comparative Remarks

Shell showing usual characters found in many other species except *K. canopi* and *K. deflecta*, which are much smaller, more elevated than that of *K. umbonis*, *K. somniator*, and *K. canopi*. Narrow longitudinal pilasters of inner penial wall similar only to *K. achernaria* and *K. hirsuta*; from which it differs most conspicuously by complex

armature of epiphallic wall (smooth in *K. hirsuta*, with lateral lamellae in *K. achernaria*).

Distribution (Fig. 207)

D'Arcy Island.

Kimberleytrachia crawfordi (Solem, 1979)
n. comb.
Fig. 208A

Torresitrachia crawfordi Solem, 1979: 91–92, pl. 7d–f; 1991: 182.

Type Locality

Western Australia, southwest Kimberley, Doubtful Bay, N of Walcott Inlet.

Taxonomic Remarks

This species was described based on one adult shell (plus a juvenile) from the type locality on the mainland while the anatomy has

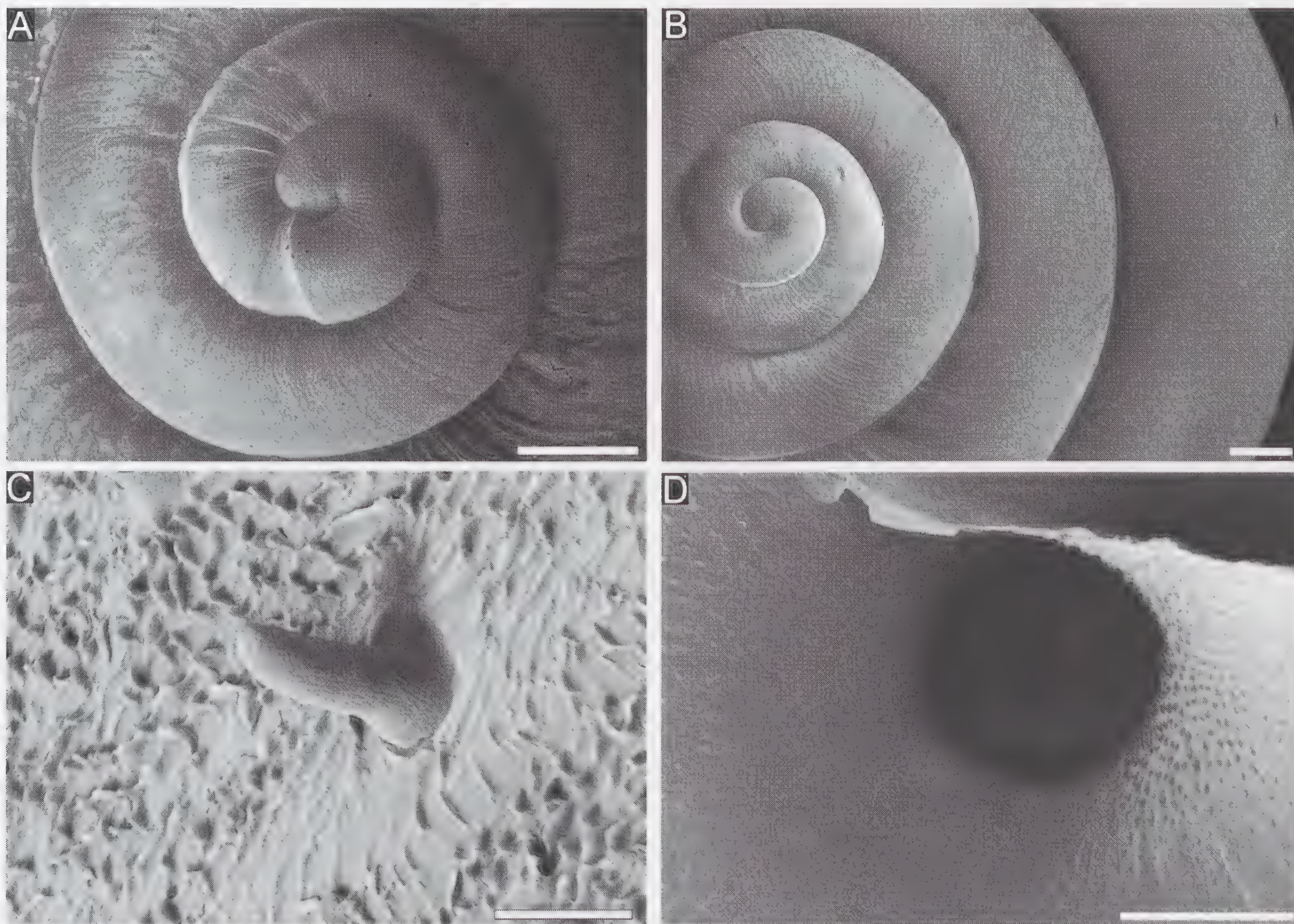


FIG. 235. SEM micrographs of the shell of *Kimberleytrachia crawfordi* AM C471821 (Storr Island). A: Apical view showing protoconch and first whorl; B: Sculpture across entire shell viewed from above; C: Close-up of periostracal hair; D: Umbilicus. Scale bars A–B, D = 1 mm, C = 50 µm.

remained unknown. Material from Storr Island is preliminarily subsumed under this name for the similar shell. Confirmation of the taxonomic status awaits comparative study of suitable material from Storr Island and the type locality on the mainland.

Material Examined

WAM S37790 (2 preserved juveniles), AM C471821 (2 shells), WAM S37833 (5 shells) from SE section of Storr Island, 15°56'54"S, 124°33'38"E; WAM S3782 (3 shells) from 15°56'39"S, 124°33'21"E.

Diagnosis

Shell (Figs. 208H, 235): Large ($D = 21\text{--}23$ mm; Table 11), delicate to thin, broadly conical with elevated spire; periphery well rounded, whorls separated by deep suture; umbilicus ~ 3 mm wide, 10–30% concealed; colour yellowish brown to amber, with lighter base. Protoconch 1.7 mm in diameter, comprising one whorl, with fine pustules. Teleoconch with faint radial growth lines, microsculpture of sparsely distributed periostracal setae and tiny ridglets, mostly worn in adult shells giving them a glossy shine; inner umbilical whorls with well-developed pustules. Last whorl weakly to moderately descending behind aperture. Angle of aperture 30–45° with the horizontal; wide, simple, with moderately to strongly expanded, weakly reflected, sharp lip; palatal node absent, basal node well developed.

Mitochondrial Differentiation

Interspecific genetic distances (1 sequence): 0.266–0.283 with respect to all other congeners (15 sequences, 7 species).

Comparative Remarks

Shell exhibits typical features known from other congeneric species except *K. canopi* and *K. deflecta*, which are much smaller; *K. alphacentauri* and *K. amplirhagadoides* differ by largely concealed umbilicus, *K. hirsuta*, *K. chartacea* and *K. somniator* by denser shell pustulation. Juvenile status of material did not permit dissection of genital organs.

Distribution (Fig. 207)

Southwestern Doubtful Bay area, including Storr Island.

DISCUSSION

Systematic Significance of Morphological Characters

In his systematic revisions, Alan Solem has established the significance of characters of genital organs and shell for the classification of Western Australian camaenids (Solem, 1979, 1981a, b, 1985a, 1997). In general, the most informative and convenient source of systematic information are characters of genital anatomy, such as, in particular, presence/absence and development of penial features like epiphallus, flagellum, penial verge or penial sheath and penial wall sculpture (Table 12). The relative lengths and shapes of organs like penis, vagina and bursa copulatrix can also be diagnostic in some cases. If using genital characters for the identification of taxa, it is essential to bear in mind that the development and relative size of some features depend both on maturity of the animal and its actual reproductive state. Among fully mature specimens (with adult shell features and fully developed albumen gland), a simple pattern of seasonal variation is found with the genitalia being inactive and reduced in size during the early to middle dry season (~ May to August) (Solem & Christensen, 1984). Seasonal variation is observed with respect to the development of organs in general but also with respect to development of the sculpture of the penial or epiphallic walls. In aestivating animals, the inactive reproductive organs may be largely reduced in size and prominence (details of the inner wall sculpture). The descriptions given here take these phenomena into account in that differences in the development of features are not used to delimit taxa, in particular when it has been clear that genitalia were in a resting phase.

Solem (1981a) found in *Amplirhagada* that in sympatric species frequently differ conspicuously in the sculpture of their penial and vaginal walls. He suggested that these characters may play an important role in mate recognition and that this function drives the evolution of distinct penial characteristics in sympatric species. Recent findings of reproductive character displacement in the genital morphology of Asian camaenids (*Satsuma*) seem to provide evidence in support of this idea (Kameda et al., 2009).

In addition to genital characteristics, most genera are relatively easy to recognise by typical combination of shell features, which include overall size and shape, width and

TABLE 12. Comparative overview of genital characteristics of the camaenid genera of the Kimberley Islands (in alphabetical order).

Species	Penial sheath	Penial wall sculpture	Main stimulatory pilaster	Shape of vergic papilla	Epiphallus	Epiphallic flagellum	Epiphallic lobe	Bursa copulatrix
<i>Amplirhagada</i>	present	variable	absent/present	verge	absent/wanting	absent	absent	simple, short
<i>Australocosmica</i>	present	variable	absent	collar	absent	absent	absent	simple, short
<i>Baudinella</i>	absent	longitudinal pilasters	absent	ring	present	present	absent	S-folded, moderately long
<i>Carinotrachia</i>	present	complex pilasters	absent	pore	absent	absent	absent	simple, short
<i>Globorhagada</i>	present	smooth	absent	pore	absent	absent	absent	inflated, short
<i>Kimberleydiscus</i>	present	pustulation	present	simple	wanting	absent	absent	simple, short
<i>Kimberleymelon</i>	present	pustulation	present	simple	wanting	absent	absent	simple, short
<i>Kimberleytrachia</i>	absent	complex	absent	ring	present	present	absent	elongated
<i>Kimboraga</i>	present	pustulation	absent	ring or verge	absent	absent	absent	simple, short
<i>Molema</i>	absent	longitudinal pilasters	absent	verge	present	present	absent	kinked, moderately long
<i>Retroterra</i>	absent	complex pilasters	absent	verge	present	present	absent	kinked or coiled, moderately long
<i>Rhagada</i>	absent	smooth	absent	verge	present	present	absent	simple or kinked, moderately long
<i>Setobaudinia</i>	present	pustulation, transverse or longitudinal pilasters	absent	verge	present	present	present	elongated
<i>Torresitrachia</i>	absent	posterior pustules, anterior pilasters	absent	ring	present	present	absent	elongated
<i>Xanthomelon</i>	present	pustulation	absent	pore	absent	absent	absent	inflated

TABLE 13. Comparative overview of shell characteristics of the camaenid genera of the Kimberley Islands (in alphabetical order); *UW = Umbilical Width.

Species	H Range (mm)	D Range (mm)	Shape	Protoconch Sculpture	Teleoconch Sculpture	Periphery	Coloration	UW* relative to Shell	Covering of Umbilicus	Sealing when Aestivating
<i>Amplirhagada</i>	8–20	15–25	broadly subglobose to beehive	radial pustulation	fine growth lines to strong ribs, smooth base	rounded to angulated	banded or uniform	narrow	partly - entirely	free/rock
<i>Australocosmica</i>	9–17	13–18	subglobose	weak radial pustulation	strong ribs, smooth base	rounded	uniform, dark	narrow	partly - entirely	free
<i>Baudinella</i>	2.5–4.0	6.5–7.5	discoidal	crowded pustules	weak to strong axial ribs, microscopic setae or hairs	rounded	uniform, light	wide	not	free
<i>Carinotrachia</i>	9–12	15.5–18.5	broadly subglobose	strong radial pustulation	coarse radial ribs onto base, microscopic pustules	keeled	uniform, light	moderate	not	rock
<i>Globorhagada</i>	16–37	16–35	globose	faint radial growth lines	variable axial pustulation	depressed	uniform, light to dark	narrow	partly - entirely	free
<i>Kimberleydiscus</i>	8–11	18–22	discoidal	faint radial growth lines	fine growth lines only	sharply angulated	banded	moderate	not	?
<i>Kimberleymelon</i>	18–27	20–30	globose	faint radial growth lines	coarse growth lines	depressed	uniform, light	narrow	entirely	?
<i>Kimberleytrachia</i>	5–15	10–24	broadly subglobose	crowded radial pustules	microscopic setae, hairs, wavy ridglets	rounded	uniform, light	narrow	not - entirely	rock
<i>Kimboraga</i>	12–19	19–25	subglobose to globose	faint radial growth lines	faint growth lines to strong ribs onto base	rounded	uniform, dark	narrow	partly - entirely	rock
<i>Molema</i>	2.5–3.5	8–9	discoidal	crowded radial pustules	strong, noduled ribs onto base	rounded	uniform, dark	wide	not	free
<i>Retroterra</i>	5–13	13–24	discoidal	radial pustulation	growth lines to strong ribs into umbilicus	rounded	uniform, dark	wide	not	free
<i>Rhagada</i>	7–15	11–21	subglobose	faint axial riblets	axial riblets or ribs	rounded	banded	narrow	partly - entirely	free
<i>Setobaudinia</i>	3–11	6–21	discoidal	regularly arranged tubercles	microscopic setae or hairs	rounded	uniform, light	wide	not	free
<i>Torresitrachia</i>	6–11	12–20	discoidal to broadly subglobose	radial pustulation	axial ribs, microscopic setae or hairs, smooth base	rounded	uniform, light	narrow	not	free
<i>Xanthomelon</i>	18–26	20–30	globose	faintly pustulose	microscopic radial corrugations	depressed	uniform, light	narrow	partly - entirely	free

sealing of umbilicus as well as microsculpture of teleoconch and to a lesser degree the protoconch (Table 13). By contrast, it has been stated for eastern Australian camaenids that the microsculpture of the protoconch is an important taxonomic feature (Stanisic et al., 2010). However, with respect to the species level, Solem (1981a, b, 1997) found that shell features are prone to parallelism and that shells are often of limited value for delimitation and recognition of congeneric species. Shells often seem to reflect ecological adaptations to a certain type of habitat and life style. In *Amplirhagada* it has been found that allopatric species tend to exhibit similar shells whereas sympatric species often differ conspicuously in their shell morphology. It has been suggested that distinct shells in sympatry may reflect the adaptation to different ecological niches within the same habitat (Solem, 1981a). On a more general basis, this may also hold for species of different genera.

Contrary to shell and genitalia, features of the digestive anatomy were found to be widely conserved or homoplastic in camaenid land snails. This confirms observations of Solem (1981a, b, 1997), who stated that in Western Australian camaenids radula and jaws are of little value for taxonomic purposes. Similar observations were made in Asian (e.g., Chiba, 1999b; Kameda et al., 2007; Chiba & Davison, 2008) and New Guinean species (Jordaens et al., 2009).

Solem's (1981a) conclusions with regard to the significance of key morphological features for the delimitation and recognition of taxa have recently been confirmed for the most diverse genus, *Amplirhagada*, by a study that combined analyses of morphological and mitochondrial evidence (Köhler, 2010c). In this study it was shown that species as delimited by their anatomy were genetically well differentiated by on average 30% Tamura-Nei distances in the mitochondrial marker COI. Exceptionally, species were separated by as few as 10% sequence divergence only. However, even these amounts of genetic differentiation do not contradict a status as distinct species as suggested based on genital characters.

Patterns of Diversity and Distribution

In general, the distributional ranges of Kimberley camaenids are characterised by allopatry and micro-endemism. Solem (1991) stated that average species ranges are restricted to a diameter of 20 km on the Kimberley mainland. Our observations on the offshore islands

are consistent with this finding. The surveyed islands vary in size from about 400 to 19,000 ha and all of them support endemic species. Exceptionally, few species occur on more than one island. Being inevitably restricted by island size, the average range of species is even smaller than on the mainland. However, island size is apparently not always a limiting factor. On the largest island, Augustus Island (~ 19,000 ha), all but one of the eleven species were found exclusively in either the northwestern or southeastern part. This observation suggests that here island size exceeds the range size of many species and that frequently species ranges are smaller than the 20 km diameter found by Solem (1991). This can be explained by two factors. Firstly, in the present revision a number of species as delimited by Alan Solem were found to be species complexes (e.g., *Globorhagada prudhoensis*, *Torresitrachia bathurstensis*, *Kimberleytrachia umbonis*). These examples may indicate that species were lumped together more frequently, which would have led to an overestimation of the size of species ranges. Secondly, observations in *Amplirhagada* suggest that there is a correlation between preferred habitat and the extent of ranges. In coastal areas, species are predominantly found in rainforest habitats but not in surrounding, more open wood- or bushland. Because rainforest vegetation is restricted to small pockets, these rainforest species are narrow range endemics found in one or few rainforest patches only (Solem, 1991; Köhler, 2010a). Further inland, however, where rainforest patches are sparse or entirely lacking, species inhabit more open woodland and rocky habitats. Since these habitats are more widespread and less fragmented, inland species usually have much wider ranges. While the precise patterns of spatial differentiation and local adaptation of populations in dryer areas of the Kimberley are currently not well understood (Solem, 1981a; Cameron, 1992; Köhler, 2010a), it is postulated that while in general the species diversity in xeric habitats is much lower, species ranges are larger overall.

Field work during the Kimberley Island Survey has recovered up to thirteen camaenid species per island (i.e., Boongaree Island where all species were found in sympatry). The average number of species per island across all 25 surveyed islands along the coast line was much lower (4.0). These figures are comparable to a maximum of 12.5 and an average of 3.7 camaenid species found per rainforest patch on the mainland (Solem, 1991). Solem

& McKenzie (1991) demonstrated that in land snails of the Kimberley patterns of species richness are correlated with attributes of rainfall, temperature and substrate. Rainfall patterns vary greatly along the coastline of the Kimberley and different islands may receive on average between > 600 mm and > 1,200 mm of precipitation per annum (McKenzie, 1991). The species richness of islands correlates well with the clinal variation of annual rainfall. Islands within the > 1200 mm isohyets support on average 6.4 species, while islands receiving between 1,000 and 1,200 mm support 4.3 species and those with less than 1,000 mm only 2.0 species.

Species found in sympatry predominantly belong to different genera while in turn congeners mostly occur in allopatry. There are few exceptions in *Amplirhagada* and *Kimberleytrachia* with up to three species from each genus occurring in sympatry on Boongaree Island and two on some other islands. The dominance of allopatric distributions suggests that spatial separation has been the main factor driving speciation in the Kimberley Camaenidae. It has been argued by Cameron (1992) for camaenids from the Kimberley mainland that allopatry in these snails may partly be caused or maintained by competition and ecological exclusion resulting in geographical replacement of species with similar ecological adaptations. Whether allopatric speciation in the island species is driven by dispersal from island to island, vicariance events relating to sea level changes or ecological replacement as suggested for the mainland species, remains to be tested.

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